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ABSTRACT

The purpose of this study is to help the industrial and vocational education fields to use the metric system, primarily in the area of industrial arts from the seventh through the fourteenth year. Specific objectives of the study were to evaluate the changeover to the metric system in other countries, to analyze selected occupations in technical areas to determine what measuring competencies would be affected by the conversion, and to develop a series of learning modules and related materials. Seven kits of materials--primarily transparency masters--were developed in major technical areas with the help of an international advisory board from major industries going metric. Regional and national seminars were offered to industrial teacher educators to acquaint them with metrics and the problems of converting their programs, and each industrial teacher education institution in the U.S. which prepares vocational and technical teachers was provided with a complete packet of the materials (included in Volume II of this report). Evaluation of the materials, made through followup study of all schools using the materials showed they were found to be useful. Included in the report are curriculum analyses for metric conversion for drafting, general metals, machine shop, woodworking, residential building construction, and graphic arts. Also included are a list of the institutions and individuals attending the teacher educator seminars, seminar course outline, and the educators' comments on the materials. (MF)

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FINAL REPORT

Volume I of Two Volumes

Project No. V257006
Grant No. OEG-0-72-1868

METRICATION OF TECHNICAL CAREER EDUCATION

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U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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April 1976

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U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
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ABSTRACT

Metrication of Technical Career Education was the first federally funded project to assist the industrial and vocational fields to change to the SI metric system. This was accomplished as follows:

1. Seven kits of instructional material--primarily transparency masters, were developed in major technical areas with the help of an internationally renowned Advisory Board from major industries going metric.
2. A series of regional and national seminars were offered to industrial teacher educators to acquaint them with the SI metric system and the problems of converting their educational program. Each industrial teacher education institution in the United States that prepares vocational and technical teachers received a complete kit of these materials.
3. Evaluation of the material was made through a follow-up study of all schools using the material. These instructional materials were found to be extremely useful in their educational programs.

It was found that if metric conversion is to be effective in industrial/vocational education, the U.S.O.E. must have a firm policy, the national associations must provide leadership and special federal funds must be available for equipment and supplies.

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Section 1

INTRODUCTION

HISTORY

For almost two centuries American industry and commerce has thrived in spite of a confusing and illogical system of weights and measures. Our customary (English) system is a hodgepodge of unrelated units that cause problems for all students and complicates every active measurement in industry. The customary (English) system is part of our heritage from the days when the thirteen colonies were under British rule. However, even though the United States for many years used a system similar to the English (imperial) system, many of these units were not exactly the same. For example, the English and its colonies accepted the imperial gallon as the basic unit of liquid capacity, while in the United States the wine gallon, a smaller unit, became standard.

After the United States gained independence many of our Presidents, including Washington and Jefferson, deplored the cumbersome measuring system and suggested changes for a more logical standardization. In fact, Jefferson devised the decimal system, and in 1785 Congress adopted the system for our currency but took no action to change the customary weights and measures.

In 1821 as a result of one of the many discussions on the problem, Congress instructed John Quincy Adams, then Secretary of State, to prepare a report and recommendations. His four-year study strongly favored the metric system because of its order, simplicity and logic. In spite of this, it was not adopted because most of our trade was with England who used their own form of the inch-pound system called the imperial measuring system.

The United States Congress in 1866 did legalize the metric system and permitted its use by scientific and other special-need groups. In 1875 the International Bureau of Weights and Measures was established and located near Paris, France. The United States was one of the signing members. The metric system was adopted as the official world measuring system. Gradually most other countries around the world joined those who already use the metric system.

Congress acted in 1967 to again consider the problem and undertook a study to evaluate the impact of metric conversion on America. The U.S. Metric Study, published in 1971 by the Department of Commerce, eventually resulted in a recommendation to Congress that:

1. The United States change to the international metric system deliberately and carefully;
2. That this be done in a coordinated national program;
3. That Congress establish a target date ten years ahead; and
4. That there be a firm commitment to this goal.

In spite of these recommendations, however, as of July 1, 1975, Congress has not approved the metric conversion bill officially. However, Congress has approved a section in the division of the Elementary and Secondary Education Act that was signed into law in August of 1974, concerning the program to require the Commissioner of Education to encourage the teaching of the metric system in all schools.

Industry has not waited for the United States Congress to act, and it has gone about the job of establishing its own program and organization for metric conversion. The American National Standards Institute in 1973 sponsored the establishment of the American National Metric Council. This is a nonadvocate group that is to coordinate metric conversion activities for business and industry throughout the United States. Figure 1-1.

Most large multinational corporations have made a firm commitment to utilize the SI metric system in all of their business activities. Such industrial giants as General Motors, Ford, Chrysler, Honeywell, International Harvester, IBM, Xerox, Caterpillar and hundreds of others are rapidly moving to the use of the SI metric measuring system. Since programs in industrial arts and vocational education have as one of their objectives representing industry and the industrial world, these areas must rapidly convert their own educational programs to the utilization of the SI measuring system. It is the purpose of this study entitled METRICATION OF TECHNICAL CAREER EDUCATION to assist the industrial and vocational fields to make this change. The way this has been accomplished is as follows:

1. To develop instructional materials consisting of seven packets of information that can be used in convert-

ing industrial arts and vocational education to the SI metric system.

2. Offering seminars in all the regions of the United States for teacher educators to acquaint them with the SI metric system and the problems of converting their educational program to metrics.

3. Providing each teacher education institution with a complete packet of the materials that are included in Volume II of this report.

IMPACT OF METRIC CONVERSION IN VOCATIONAL AND TECHNICAL EDUCATION

Perhaps no area of our educational system can be more greatly affected by metric conversion than the areas relating to industrial arts and vocational education. This is true because these areas represent the industrial world; therefore, they must use the system of weights and measures that is used in engineering, manufacturing, construction and supportive activities. However, the problem is more than just a change of measuring language. In the math and science field metric conversion will be concerned primarily with teaching students the SI metric measuring system. This is a relatively simple job in contrast to what the industrial and vocational fields face. In fact, in industrial arts and vocational education learning the metric system of measurement only will require approximately twenty-five percent of the total educational time devoted to metric conversion. Figure 1-2. The two other and more significant aspects of metric conversion are those dealing with the application of metric measurement to drawings, tools, machines and other devices and an understanding and application of the national and international metric standards for materials that are currently being developed. A word of explanation on the last two will provide some insight to the complex problem of metric conversion in the vocational and technical areas. Look for a moment at the second problem, namely that dealing with the application of metric measurement to drawings, tools, machines and other devices. In teaching the metric measuring system the only concentration would be on the basic unit of length, namely the metre, with its principle multiples and submultiples the millimetre, centimetre and kilometre. However, in applying these linear measurements in industrial education the problem becomes far more complex.

For example, in the field of drafting the student must be taught how to use a metric drafting scale, the

various ways of adding metric dimensions to drawings, the problem of rounding metric units and many others. In the area of machine shop, a student must know how to read a metric rule, micrometer, vernier caliper and many other measuring tools that will be in metric units. For example, there are four different types of metric micrometers, each of which will require different learning techniques. In addition to this, the student must learn how to use dual-reading dials on a lathe, adjust the lathe to cut metric threads, be able to read a digital readout unit on a milling machine and many other applications of the linear measuring system to the tools, machines and devices used in industrial-vocational education.

The third aspect of conversion, namely understanding and applying national and international metric standards is by far the most complex aspect of metric conversion. Today there are only about one hundred fifty metric standards of materials while it is estimated that before complete metric conversion can become a reality there is need for approximately eleven thousand different engineering and industrial standards. One of the first national metric standards developed for U.S. industry was that for metric threads. The Industrial Fasteners Institute spent approximately two years and over one-half million dollars to develop the Optimum Metric Fastener System (OMFS) to use for all threaded fasteners for all new products. Figure 1-3. This standard was included in ISO standards in 1975. This is only one of the eleven thousand standards that will need to be developed. Since it will be many years before all of these are available, there will be the continuing problem of teaching industrial and vocational students about the new standards as they become available and also how to use metric materials made from metric modules.

SPECIFIC OBJECTIVES

In the proposal submitted to the U.S. Office of Education for approval, the following five specific objectives were listed:

1. Study the economic implications involved in the United States moving to the metric system.
2. Evaluate the changeover to the metric system now underway in England, Australia and several other of the Asian-Pacific countries, and how this changeover has affected technical education.
3. Analyze selected occupations and technical areas to determine what necessary measuring abilities and competencies would be affected by the changeover to the metric system.

4. Recommend changes in career education including the instructional materials, machines and tools needed to convert to the metric measuring system.

5. Develop a series of learning modules and related materials of the metric system suitable for teaching in the technical and occupational areas for distribution to teacher educators.

Several of these objectives are closely related to developing the learning modules. The specific objectives as they developed during the course of this project are organized more logically in scope and sequence as follows:

1. Evaluate the changeover to the SI metric system now underway in other English-speaking countries, principally Canada, England, South Africa, Australia and New Zealand.

2. Analyze selected occupations in technical areas to determine what necessary measuring abilities and competencies should be affected by the changeover to the metric system.

3. Develop a series of learning modules and related materials on the metric system suitable for teaching in technical and occupational areas for distribution to the teacher educators. As part of this objective, there are recommended changes in career education including course of study, tool kits, machine conversions and many other recommendations. The sub-objectives of this major objective are as follows.

A. Make curriculum analyses for metric conversion. Before the instructional packages could be developed it was necessary to make curriculum analyses of each area to determine the kind and amount of metric measurement that is involved in each of these areas. It was also necessary to survey various groups to determine the status of metric conversion in 1972.

B. Develop the instructional kits. Based on an evaluation of the curriculum analyses of the major areas in industrial education, it was decided to produce seven kits of material to include in the total instructional package. These are:

1. Going Metric for Students
2. Going Metric for Career Education
3. Going Metric in Drafting
4. Going Metric in Metalworking
5. Going Metric in Graphic Arts
6. Going Metric in Woodworking and Building Construction
7. Going Metric--Course of Study, Lists of Tools and Related Materials

C. Use of advisory committee. During the first year of the study in 1972 and 1973, most industrial educators along with other areas of education had little knowledge of the SI metric system or its implications on future curriculum development. Therefore, it was decided that to develop these learning modules it was necessary to secure qualified and competent help from leaders in industry who have been going metric. This advisory committee not only aided in developing the learning modules, but they also evaluated their technical accuracy.

D. Seminars. After the material was developed it was felt that the best way to reach the some two hundred thirty five industrial teacher education institutions in the United States would be to hold a series of regional and national seminars. A total of nine of these seminars were held.

E. Costs of conversion. Obviously this study could not be concerned with the total cost of metric conversion in the United States. This is a problem that is of great concern to groups such as the American National Metric Council and other national organizations. However, based on the studies made as part of this project to determine costs of measuring tools, conversion units and new equipment, it is possible to provide some insight into the overall costs of metric conversion in the specific technical areas involved in this study.

F. Evaluation. Three methods were used to evaluate the quality of the instructional materials. One was to secure the evaluation after each of the seminars were held. The second method was an indepth seminar at Colorado State University. The third method was a follow-up survey form sent to each of the schools in the United States receiving the material.

G. Other activities. While not directly a part of this project, the Center for Metric Education developed an instructional kit entitled, GOING METRIC IN HOME ECONOMICS. Also, several large three-dimensional teaching aids were built such as a rule, vernier and micrometer.

EFFORTS AND PROCEDURES

Because of the nature of this study, a wide variety of methods and procedures were used in collecting the data, developing the instructional material, disseminating the materials and evaluating their effectiveness. Among these were the following.

1. Establish a metric library of all available

instructional materials that could be secured from all countries presently going metric.

2. On-site visits to various countries going metric. Also visitation with representatives of countries that are underway in metric conversion. On-site visits were made to England and Canada. Visitations with metric personnel were made with representatives from South Africa, Australia and New Zealand.

3. Secure all instructional materials on metric conversion that are being utilized by the major industries currently going metric. For example, all of the instructional materials in drafting and other areas were secured from such companies as International Harvester, General Motors, Caterpillar, International Business Machines and many others.

4. Establish an advisory committee of competent metric experts to help in evaluating the quality of the material.

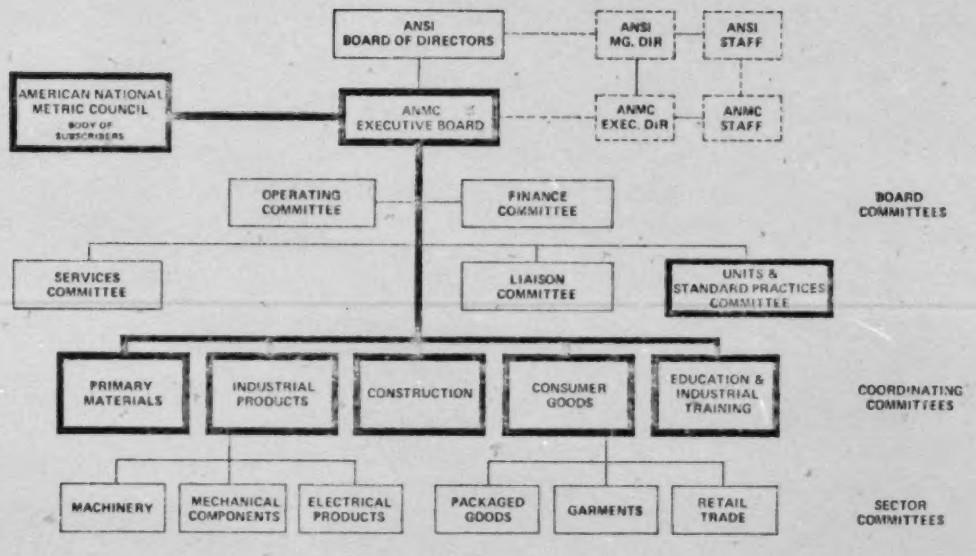
5. Utilize metric experts in technical areas to review the learning modules that were developed. Each learning module was reviewed by one of the technical experts represented by the advisory committee. For example, the President of the American National Standards Institute, who also serves as Director of Metric Standards for General Motors Corporation, reviewed every aspect of the kit GOING METRIC IN DRAFTING.

6. Personnel from the Center for Metric Education traveled to various regional and national conventions to present half-day seminars for teacher educators.

7. The survey method was used to contact each teacher education institution in the United States who secured a complete copy of the kit to determine its effectiveness.

Figure 1-1

AMERICAN NATIONAL METRIC COUNCIL
ORGANIZATION CHART



Note: The coordinating and sector committees listed above are typical but only preliminary. A comprehensive committee structure along these lines is being developed.

Figure 1-2

ANALYSIS OF INSTRUCTIONAL TIME ALLOTMENTS

METRIC MEASUREMENT AND INTERNATIONAL STANDARDS

INDUSTRIAL AND TECHNICAL AREAS

		INSTRUCTIONAL TIME
Metric Measurement SI	Base Units Derived Units	25%
Application of Metric Measurement to tools and machines and drawings	Tools: rule, scale, micrometer, vernier, dial indicator, etc. Machines: dual reading dials Printings and Drawings	25%
International Standards - ISO	Screw threads Bearings Gears Papers Splines Plus about 10 000 other standards	50%

Figure 1-3

First Progress Report, January 5, 1971

A Study to Develop an Optimum Metric Fastener System

ENGINEERING REPORT

Industrial Fasteners Institute
1505 East Ohio Building
1717 E. 9th Street
Cleveland, Ohio 44114 USA

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Section 2

EVALUATION OF THE CHANGEOVER TO THE METRIC SYSTEM UNDERWAY IN ENGLAND, AUSTRALIA AND SEVERAL OTHER ENGLISH-SPEAKING COUNTRIES AND HOW THIS CHANGE-OVER IS AFFECTING VOCATIONAL TECHNICAL EDUCATION

A four-pronged approach was used to evaluate the changeover to the metric system underway in English-speaking countries, namely

1. On-site visits to England and Canada to evaluate their problems and procedures.
2. Personal discussions with leaders in the field of metrication in South Africa, Australia and New Zealand at the biannual ISO Convention in Washington, D.C.
3. Correspondence and publications from countries going metric.
4. Other research.

METRIC CONVERSION IN ENGLAND (UNITED KINGDOM)

In 1965 England made a commitment to convert to the metric system over a ten-year period. The Metrication Board was established with Lord Richey Caulder as the first Chairman and Mr. Gordon Bowen as Executive Director. When the first meeting of the Board took place in May, 1969, it was decided that emphasis on metric conversion should take place in the manufacturing and construction industries and that conversion in the consumer sector would come at some later date.

In January, 1972, the Director of the Center for Metric Education at Western Michigan University attended a conference on metric conversion in Chicago at which time he had an opportunity to meet and visit with Mr. Gordon Bowen, the Executive Director. At that time Western Michigan University had informal information that they would be granted a three-year project to study metric conversion as it affects technical career education. Therefore, plans were made for the Director of the Center for Metric Education to visit England to evaluate their problems and progress. Through the office of the Metrication Board an intensive visitation program was planned to obtain an overview of the problems of metric conversion particularly in the area of vocational and technical

education. The itinerary for a visit on the sixth of April is shown as Figure 2-1.

Through the offices of the McGraw-Hill Book Company in New York arrangements were made to spend a day at McGraw-Hill International Book Division in England to discuss the problems of textbooks in facing metric conversion. Figure 2-2. Another day of visitation was arranged to attend the Institute of Craft Education at Avery Hill. Figure 2-3. This group is the equivalent of the American Industrial Arts Association Convention. Following is a brief discussion of each of these meetings.

Metrication Board Activities

Mr. Gordon Bowen provided the Director with a briefing of the overall activities of the Metrication Board. There was also a shorter visit with the Chairman of the Board, namely Lord Richey Caulder. The primary discussion concerned the extensive conversion program, which was taking place in the area of manufacturing and construction. After this briefing there was a visit with his Majesty's Inspector of Schools, which would be the equivalent of the Commissioner of Education in the United States. He explained the overall pattern of instruction in metric conversion in which emphasis is given at the elementary level on teaching exclusively metrics with no conversion to the imperial system. Another visit was made to the City of Guilds of London Institute. This group is responsible for developing competency tests in the area of trades and industrial education. It was indicated that all competency tests developed since 1970 include SI metric units.

The second day was spent with the editors and president of McGraw-Hill International Book Division at Maidenhead, England. This is the largest vocational-technical publisher in England, and it has been in the roles of metric conversion since 1970. The Director had been assured by the Metrication Board that all textbooks at high school level and below must be only in metric units. There must not be dual dimensioning, and imperial units were not to be used. At above high school level, namely technical institutes and colleges, texts were to show both the metric units and the imperial units. The major problem faced by the textbook publishers in 1972 was that England did not have an adequate inservice education program for teachers, particularly in the area of industrial arts and vocational-technical education. As a result, while textbooks were available in metric units

only, teachers continued to use the old imperial editions because they were more familiar with the units and had greater confidence in it.

The third day was spent at the annual meeting of the Institute of Craft Education. This meeting was held on the college campus and included a variety of programs on teaching craft education as well as the typical commercial exhibits of manufacturing tools, materials and textbooks. Since the conference was held on the campus of a teacher education institution that prepared craft teachers, it was also possible to view the physical plant to determine what affect metrication had had on teacher education. The main problem in craft education in England in 1972 was that no funds were available for converting equipment to metric units. Therefore, there was little evidence in the training program that much work had been done in teaching metrics. The textbooks that were on display were available in the SI or metric editions, but no measuring tools or machines were on display showing metric units.

In preparation for the visits to England the following lists of problems were identified and an attempt was made to determine the answers to each. These were as follows:

1. What was the major problem in converting to the metric system in the educational system of England?
   - A. Revised text and instructional material
   - B. Inservice education for teachers
   - C. Resistance to change
2. What were some of the major problems in converting vocational and technical education?
   - A. Replacement of tools including measuring devices
   - B. Conversion of equipment
   - C. Instructional and text materials
   - D. New drawings, etc.
3. Was the dual-dimensioning system, namely, the imperial and the metric system used during the early transition years?
4. What provision was made for replacing measuring tools and other necessary equipment in the educational programs?
5. At what level in the educational system was metrics first introduced?
6. How much on engineering standards such as thread forms, bearings, gears, etc., were (or are) included in current vocational/technical education materials?
7. What kinds of teacher education programs were carried on during the early years of conversion to the metric system?

8. What was the cost of converting educational systems to the metrics program at the elementary or primary grades, at the high school grades and at the post-high school grades?

9. Were the training materials used by industry for converting to the metric system the same as those used in the educational system?

10. How much metrics is taught at each level, and what kinds of limitations are put on metric education? For example, in the timber (woodworking) industry we note that the only length measurements used are metres and millimetres.

11. Was there an overall pattern of planning and converting to the metric system in the vocational programs? If so, who was responsible for it?

A summary of the answers to these questions are given below. Specific comments concerning metrication are listed in Figures 2-4, 2-5, 2-6 and 2-7.

1. All instructional material was developed using only the SI or metric units. This is particularly true of all textbooks at the high school level or below. However, there was no organized program for inservice education, particularly for industrial and vocational teachers. As a result, there is a great deal of resistance to change and teachers continue to use the imperial units along with their textbooks.

2. The major problem in converting in vocational and technical education was the replacement of measuring tools and the conversion of equipment. No government funds were provided for these items.

3. During the early stages of metric conversion, dual dimensioning was used in the manufacturing industry. However, beginning in the early 1970's the trend was to utilize only metric measurements on drawings used in manufacturing.

4. There was no organized government finance program for replacing measuring tools.

5. Metrics was introduced at the elementary level on an organized basis. In fact, metric instruction was most effective at this level.

6. All British standards, established by the British Standards Institute (BSI), were based on ISO standards as available. One of the first changes to be made in England was to accept the ISO metric threads to replace all of the imperial threads. However, there were not a great many standards available in the area of woodworking and some of the other construction areas.

7. There were no formal teacher education programs for metric conversion at the industrial and vocational levels.

8. No cost studies were available at the time concerning metrication.

9. Each industry developed its own metric conversion materials. This was particularly true in the construction and graphic arts industries, who did an excellent job of developing basic metric conversion instructional materials.

10. Education in England developed a scope and sequence chart outlining the amount and level of metric instruction to include at each grade placement level. This was well organized and in good pedagogical form.

11. There was no overall plan for converting to the metric system in industrial and vocational programs.

Following are some general impressions concerning metric conversion in England in the Spring of 1972.

1. The average visitor to England in the Spring of 1972 found little or no evidence that there was a metric conversion program underway. This is true because of the fact that the consumer aspect of metric conversion was largely ignored. There had been no conversion of grocery products, milk and many other consumer items. There had been no changes in textiles and clothing. No evidence or change could be found in road signs or speed limits. There was almost a complete lack of metric conversion information at the consumer and adult level. This caused a dualism in the country's life style. Since manufacturing and construction were completely converted to metrics, the workers in these areas had to use SI metrics in their work. Also since SI metrics was taught extensively at the elementary school level, most children were well acquainted with the system. As a result, they developed a dichotomy in which for everyday life the imperial system was the standard way of measurement, but for industry and education the SI metric system was predominant. This caused a great deal of resentment toward metrics. In fact, the majority of people over forty years of age in England resented metric conversion programs. They blame much of the problems of inflation on metric conversion.

2. Conversion to the metric system in instructional materials, particularly books, has moved forward much more rapidly than the use of the metric system in schools. Since the new editions of all industrial and vocational texts were pure SI metric, it was difficult for the teachers not well acquainted with the system to utilize the text. England did not do as the United States may in going through a series of steps in book publishing to convert from the old to the new system. Because inservice education for craft teachers in England did not keep pace, most of the actual teaching in the laboratories in 1972 utilized the imperial system.

3. There were inadequate provisions by the government for replacing and modifying tools and equipment. The craft areas of education, commonly called practical education in England, have been traditionally hand activities and did not clearly represent the industrial world. However, a reasonable number of machines such as lathes, drill presses and so forth were added to the curriculum. Because of the lack of funding, metric measuring tools and conversion units were not available to the teacher.

OTHER RESEARCH

The American Institute for Research in the Behavioral Sciences at Palo Alto, California, received a grant from the National Institute of Education with the title, Going Metric: An Analysis of Experiences in Five Nations and Their Implications for U.S. Educational Planning. This study reviewed the problems of metric conversion in the United Kingdom (England), Australia, South Africa, New Zealand and Canada. They utilized several techniques to secure their information including:

1. information from key representatives in each of the five countries,
2. collection of information on metric conversion in various areas,
3. reviewing literature from the countries involved,
4. and direct surveys of each country's companies.

As a result of an extensive study, the report suggests the following as some of the major problems faced by the United States as it goes metric. While this study surveys the total field of education, it may have some implications for industrial and vocational education. In the section under "Findings on Instructional Strategies" there is a short section on vocational education, which indicates the following:

> "Some of the most far reaching changes have occurred in the area of industrial education affecting the sizing of lumber, nails, screws, nuts, drills, taps and dies, as well as the units expressing the speed of various machines and the dimensions of drawings. This did not require that all existing tools and machinery need to be replaced, however. Most hand tools and many standard machine tools may be used regardless of the measuring units.

From the Research and Curriculum Branch of the Department of Education in Queensland, Australia,

come the following interim measures that might assist teachers and students during the conversion period (1973, p. 14):

Simple metric scales may be constructed and attached to instruments to replace imperial scales;

Metric size tools may be marked in some distinctive way to distinguish them from other tools;

A set of drills approximating metric sizes may be made up from existing number, letter and inch-dimensioned drills.

As an experiment, in Western Australian technical colleges all imperial measuring devices were removed from some metalworking classrooms and replaced by metric devices. With no special instruction in the use of metric devices, the students achieved the same rate of success as they had with imperial unit devices. A similar experiment was conducted in woodworking classes with about the same results.

In technical education it was found that many major items may be built or converted by the students themselves, providing a worthwhile learning experience in addition to assisting in equipment modification."

The above section does not clearly indicate the total scope of the problem involved in conversion in industrial-vocational education contrasted with other areas of education. In industrial and vocational education there are three basic areas of education and change that must be dealt with.

1. The SI metric measuring system. Learning the SI metric measuring system will be only a small part of the total problem of metric conversion in industrial-vocational education. This is in contrast to areas such as math and science where learning and measuring systems will be the primary responsibility. It has been estimated that only approximately twenty to twenty-five percent of the instructional time needs to be spent on metric measurement as such.

2. Application of the metric measuring system to measuring tools, drawings, machine conversions and so forth. A large part of the training in industrial-vocational education must be concerned with teaching students how to read measuring tools in the metric system. This is more complicated than it first may appear. For example, there are at least four basic types of

micrometers available for instruction, each of which is read in a different manner. Another problem is even though a student may learn to use a metric rule as such, it just does not automatically mean that he would be able to use a metric drafting scale using the various common scale ratios. Also, the student in the machine shop area must be taught how to read dual reading dials, digital readout units and to make the necessary changes in gearing to cut threads.

3. Standards. By far the major problem facing industrial-vocational education is to teach students about the engineering standards that will be available in the years ahead. Currently only about one hundred fifty engineering standards are available in metric units. It has been estimated that at least eleven thousand are needed for all areas in order to have a truly metric conversion. One example of the complicated nature of this problem is illustrated by the time and money spent by the Industrial Fasteners Institute to develop a metric thread standard for the United States. After approximately two years of work and almost one million dollars, this institute which represents major American manufacturers, has come up with a twenty-five size series of metric threads called the Optimum Metric Fastener System. This is only one of the eleven thousand standards needed for our industrial society. For a student to understand the Optimum Metric Fastener System, he must also know the ISO metric fastener system and the relationship between the two. In the OMFS system all the sizes except one, namely 6.3 mm, are interchangeable with the ISO metric threads. However, the OMFS thread series is designated differently on drawings, and it uses different sizes of wrenches.

The above description does not truly indicate what the problems are. In fact, it gives a wrong impression as to what is happening. For example, it was said that in industrial education nails, screws, etc., are being affected by metric conversion. In the area of woodworking, wood screws, dowels, nails and so forth will not change in size. However, in the area of metalworking, machine screws, bolts and other items of this type will change in size.

Based on the experiences of other countries, the following are recommendations for implementing the metric conversion in industrial and vocational education.

1. Develop adequate inservice education programs for all industrial education teachers now in the field. Without an organized program of inservice education, the great majority of teachers now in the field will resist

metric conversion. They will continue to use the customary (English) system of units as long as possible. Therefore, an organized state-wide program of inservice education is an essential part of a good metric conversion program.

2. Develop a preservice education program for all teachers now preparing for the field. To be effective, each of the some two hundred thirty five teacher education institutions in the United States must convert their own teacher preparation program and include metrics in all of the technical courses. As a result of this current study, every teacher education institution in the United States does have a complete set of the instructional materials. Utilization, however, is another matter.

3. Provide some kind of state and/or federal funding for conversion of equipment. While industry can convert to the metric system as a cost-saving technique, or it can pass the costs of conversion on to the customer, this is not possible in the area of education. Costs of conversion in areas such as math and science will be relatively small. However, there are certain areas in industrial and vocational education in which costs of conversion can and will be substantial. As indicated in another section of this report, costs of conversion in machine shop in the United States could range anywhere from approximately $50,000,000 to $250,000,000. If some kind of state and/or federal fundings are not available, metric conversion will be on a hit and miss basis.

4. Develop a nationwide system of disseminating information concerning metric standards and industry progress in metric conversion. One of the problems for industrial and vocational educators in the years ahead will be to keep up to date on the metric standards as they are written. Also, as metric materials in metric modular sizes become available, some group or organization must provide a service to the field that will give teachers updates on a monthly basis on what is happening in these areas.

5. Publishers of instructional material should develop a coordinated approach to convert all instructional materials to metrics. The United States should not make the blunder that was made in England in which there was only one conversion from imperial units to SI units without any immediate steps. In the United States textbooks should be converted in at least a two or three stage process. The stages of conversion might be as follows:

A. Revision including the customary (English) units as the predominant measuring units with the metric

equivalents in parentheses behind each measurement.

B. Metric units should be the predominant units with the customary (English) equivalents in parentheses behind each measurement.

C. The last revision should be an all metric revision.

During the ten or fifteen years it will be necessary to go through these three stages of revisions many of the metric standards for materials will be developed, and therefore, can be included in each of the new editions. For example, anyone producing a textbook on carpentry and building construction at the present time would find that the standards are only now being written and probably will not be finalized for at least another year. This will mean that it will be at least five to ten years before the actual materials for building construction will be available in metric modules. Therefore, by the time the second or third revision of a textbook on carpentry is available in a predominantly metric measurement edition, most of the standards might be available.

Figure 2-1

Mr. John L. Feirer

Visit to London 6 April 1972

PROGRAMME

TIME	TO MEET	VENUE
0930 - 1045	G BOWEN Director Metrication Board	Metrication Board 22 Kingsway London WC2 (Tel: 242 6828)
1100 - 1145	A D COLLOP Her Majesty's Inspector of Schools	Department of Education and Sciences Room 6/15 Elizabeth House York Road London SE1 (Tel: 928 9222)
1200 - 1230	A N A WARD Metrication Officer	City and Guilds of London Institute 76 Portland Place London W1 (Tel: 580 3050)
	LUNCH - City and Guilds	
1410 - 1428	By rail from Euston to Watford	

TIME	TO MEET	VENUE
1430	E PENNANT JONES Senior Training Advisor and Metrication Officer EITB	Engineering Industry Training Board 25 Woodford Road Watford WD1 2 PD (Tel: 922-5751 Then - by car to Aylesbury Technical College to see practical work in metrication training using metric units

Figure 2-2

March 2, 1972

Mr. Gordon Graham
Managing Director
McGraw-Hill Publishing Company, Ltd.
McGraw-Hill House
Maidenhead, Berkshire, England

Dear Gordon:

I am sorry I missed you last time, but maybe on the next go around.

May I ask a favor? John Feirer, Professor and Head of the Industrial Education Department, Western Michigan University and author of several high school texts for us, will be visiting England in early April. His mission, made possible by a Federal grant, is to study the problems encountered in converting to the metric system.

John called this morning to ask if it would be possible while he is there, to visit with some of your people to discuss their experiences in dealing with the change over in text material. I have taken the liberty of assuring him that he will be most welcome, and have urged him to write directly to you to confirm possible dates and times.

I do appreciate your help, and know that John will profit from a session with you experienced veterans.

Best wishes to your family.

Sincerely yours,

D. Eugene Gilmore
Senior Editor

DEG/mam
cc: Dr. J. L. Feirer

McGraw-Hill International Book Division

European Headquarters, Maidenhead,
Berkshire, SL6 2QL, England
Telephone Maidenhead 23432
Cables MCGRAWHILL ENGLAND, Telex 84484

W. Gordon Graham
Group Vice-President

Professor John L. Feirer
Industrial Education Department
Western Michigan University
Kalamazoo
Michigan 49001
U.S.A.

7th March, 1972

Dear Professor Feirer,

I was pleased to learn from Gene Gilmore and from your own note of March 2nd of your impending visit to London.

On your arrival, please telephone John Churchill, the Publishing Director of this company, and he will render you whatever help he can.

As it happens, we have built our technical education department largely since metrication became a textbook requirement, so we have a fair amount of experience in the matter which you are going to study.

I am afraid that I shall be away during the time of your visit, but I have ascertained that Tuesday, April 4th will be convenient to my colleagues, who look forward to meeting you. It is just a 40-minute trip from your hotel to this office, and Mr. Churchill will give you exact directions when you speak with him.

With best wishes for a successful mission.

Yours sincerely,

W.G.G.

April 10, 1972

Mr. John Churchill
Publishing Director
McGraw-Hill International Book Division
European Headquarters
Maidenhead, Berkshire, SL6 2QL
England

Dear Mr. Churchill:

My visit with you and your editors on Tuesday, April 4, was most fruitful. As you know, our first responsibility is to prepare instructional material, and there is no better place to find out what was happening in England than to spend some time with your people.

As I indicated to you at lunch, Dr. Robert Worthington will be coming to England within the next several weeks and would like to visit you. Your offer to provide him any kind of services and information is greatly appreciated.

I am enclosing with the letter to David a copy of the current edition of the Industrial Teacher Education Directory.

Thanks so much for the excellent lunch at Ye Old Inn. We will look forward to receiving the books.

Sincerely,

John L. Feirer, Director, Center for Metric Education
Industrial Education Department

jt
cc: Mr. David Howgrave-Graham
Dr. Robert Worthington, Assistant Commissioner
Voc. and Adult Educ., U.S. Office of Educ., Depart, of HEW
Washington, D.C. 20202

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JAC/DP

18th April 1972.

Professor John L. Feirer,
Director, Centre for Metric Education,
Industrial Education Department,
Western Michigan University,
Kalamazoo,
Michigan 49001,
U.S.A.

Dear Professor Feirer,

Many thanks for your letter of April 10th. Let me say again how much we all enjoyed your visit. David tells me he has already received the Directory that you mention, and that the order for the books we discussed has been processed.

We will be very happy to see Dr. Robert Worthington when he is here, and I hope we will be able to help him as best we can. I have written to him separately to say we will be pleased to have him here and have told him to either contact Tom Blackall, David Howgrave-Graham or myself when he arrives in the event that anyone of us is actually out of the office the day he phones.

With kind regards,

John Churchill.

JOHN CHURCHILL
Publishing Director.

Figure 2-3

INSTITUTE OF CRAFT EDUCATION

CONFER IN KENT

FOLKESTONE
1952

CANTERBURY
1962

AVERY

HILL

1972

Figure 2-4

GENERAL IMPRESSIONS OF METRICATION

1. Metrication in England is operating by bits and pieces--industry by industry--and not by any coordinated program.

2. Industry and commerce are not mandated to convert to metrics. It is possible that this might happen with a change of government.

3. Some industries are forcing metrication by increasing the prices of the old imperial sizes. For example, beginning in the Spring of 1972, the imperial size of bolts, nuts and machine screws will be much more expensive than the metric sizes.

4. Book publishers are in a quandary at the high school level and below; no books can be sold that do not say "Metric Edition" or "SI Metric Units" on the cover. The Metrication Board would prefer to have the school books listed only as the metric edition. They think the addition of SI tends to make it sound more difficult. All textbook publishers are now converting all texts directly to the SI units. There is no dual dimensioning of any type. This is true of all school books.

5. In the engineering books where many are sold to the trade, the publishers are hedging their bets. They are including both the imperial and the metric units. For example, the book specified concrete by the cubic yard and also by the cubic metre. The Metrication Board would prefer only SI metric units in engineering texts. But this is difficult because of the many older and experienced engineers who are still using many units in imperial.

6. All syllabi and tests for teacher certification are in SI metrics.

Figure 2-5

METRICATION IN THE DRAFTING ROOM

1. Drafting has been completely converted to SI metric units.

2. No dual dimensioning is used in drafting except in rare cases. All drafting books show the SI metric units and the measurements are thus shown.

3. Measurements in metric for metalworking should never be carried beyond the second decimal place in millimetres. Some engineering societies are still showing it to the third decimal place. This is beyond the reach of accuracy of most machine methods.

4. Scales used in metrics have common scale sizes such as 1:1, 1:5, 1:50, 1:1.25, 1:2.50, 1:200, 1:100.

5. All types of drafting aids including all types of templates are available in metrics.

6. There are many drafting books available, all in SI metrics.

7. Dual dimensioning is discouraged by the Metrication Board as a general policy. They do not believe in dualism.

8. Many schools have used the shock treatment in converting to metrics. The old edition of all texts were in imperial units, while the new books are exclusively in SI metric, with no dual dimensioning. No books can be accepted or used that are not totally SI metric.

9. Drawings of wood products are made to rounded millimetres only. The only established measurements used are the metre and the millimetre.

Figure 2-6

METRICATION IN THE METALWORKING INDUSTRY

1. The metalworking industry has been the most difficult one to convert and is still not fully metricated.
2. Because of the many problems involved in metrication, a special booklet on Metrication of Machine Trades was produced.
3. Most metalworking equipment in the schools is still imperial. The hope is that within a few years about half will be in metric measurement.
4. The first step in conversion beside buying the necessary measuring tools was to convert the cross-feed screw and the compound rest screw and nut on the lathe so that it would read and operate in metrics. This is as far as much of the metrication goes in the school machine shops.
5. Some lathes are converted by adding a set of change gears and a new lead screw for cutting metric threads.
6. Metalworking machine manufacturers now produce a fully metricated lathe as far as operating parts are concerned but still produce to imperial standards. In other words, if the gear box, lead screw, cross-feed screw and compound rest screw are all in metrics, they also have an arrangement whereby a dial indicator is attached to the carriage for cutting metric threads to alleviate the necessity of leaving the foot nut closed for all thread metric sizes.
7. Only coarse ISO metric threads are used and taught. The fine thread series is completely ignored and only twelve sizes are used from twelve to twenty-four millimetres in diameter.
8. As a result, only twelve taps and dies and metric drills are needed to complete this set.
9. Die stocks are currently being made with the ISO metric thread--coarse series--but with the outside diameter of the die still in imperial sizes so that they can use the old die stocks. The school, therefore, need only buy twelve taps, twelve new button dies, and twelve drills to do all the thread cutting that is needed.
10. There is a conversion dial available which eliminates the need to replace the screws and nuts on lathes, milling machines, etc.
11. ISO metric threads--coarse series--is universally used in industrial manufacturing. The only place ISO metric threads--fine series-- are used is in fine precision equipment such as microscopes, etc.

12. The best set of standards for all metalworking are the Germin din standards.

13. ISO does not have many standards yet in metalworking.

Figure 2-7

METRICATION IN THE TIMBER (WOODWORKING) INDUSTRY

1. The timber industry gave leadership to conversion to the metric system at an early date in England. It is supposedly fully metricated with a few exceptions.

2. The main problem is, however, that the conversion in the woodworking industry is largely a soft or mathematical metrication rather than a hard actual change in size.

3. The only tools that are fully metricated are the measuring tools. There are none other.

4. The only sizes used are the metre and millimetre and multiples of them, such as the square metre and the cubic metre.

5. No other woodworking tools are metricated except the sizes indicated in millimetres. For example, chisels and boring tools are manufactured exactly as before except that they are specified in metric sizes.

6. The British Standards Institute has developed ninety-six recommended sizes of lumber. However, approximately forty of these are not available since most lumber is imported from Canada, Norway and Sweden.

7. The lumber in these countries is cut in the imperial system but is billed to England in the metric system.

8. Lumber is sold in England in the metric system with the basic unit of measure the cubic metre. This is a rather large unit so that the cost quotation of the cubic metre is quite large.

9. Panel stock comes primarily from Canada and several other foreign countries and is quoted in millimetres; mainly, 1220 x 2400, which is a 4 by 8 foot sheet.

10. Lumber sizes are selected on a mathematical basis and not on a use basis as they developed in our country.

11. The building construction industry has approved a 300 millimetre (about one foot) modular design. However, panel stock is not available in this modular size, and, therefore, must be trimmed on the job if the project is designed to this modular unit.

12. The only changes in woodworking machines that appeared were that wherever there is a scale, it is shown now in either all metrics or in combinations of metric and imperial. This is the only change in woodworking machines.

13. There has not been a metric framing square designed. The Director of the Center for Metric Educa-

tion was the first one to bring this before the Metrication Board, and they are looking into the matter.

14. All woodworking books are being converted into SI metric measurement.

15. Metric measures in woodworking are rounded off to full millimetres. Therefore, the old inch dimensions would be shown as twenty-five, the two inch as fifty, etc.

16. Dowels continue to be manufactured and sold in imperial sizes, and this will continue. Dowel sizes will not change since they are related directly to the boring tools.

17. Wood screws are available only in imperial sizes. However, the charts show the metric size drills to use which often are imperial drills with metric markings.

18. The paint and varnish industry has largely converted to metric size containers. They are sold in rounded off litres, half litres, two litres, etc.

Section 3

Part A

CURRICULUM ANALYSES FOR METRIC CONVERSION

To determine what affect metric conversion will have on industrial education programs, it is necessary to make a detailed task analysis of specific courses to determine what implications there are for SI metric measurements in the various instructional units included in that course. Since this study is primarily concerned with several of the more basic technical courses in industrial-vocational education, an analysis has been made of the five major occupational areas in which instructional material has been developed. These include machine shop, general metals, graphic arts, drafting, woodworking and residential building construction.

To determine the metric implications a list of instructional units more commonly taught in the basic courses was established by analyzing the major textbooks and curriculum materials available in each of these areas. On the basis of this analysis a list of instructional units was established.

In SI metrics there are three different types of units--base, supplementary and derived. The seven base units include units of length--metre, mass--kilogram, temperature--degrees Celsius, time--second, electrical current--ampere, luminous intensity--candela and amount of substance--mole. Of these the three most common applied base units are length, mass and temperature. The others are less commonly encountered except in technical areas. The supplementary units are not commonly used. Of the hundreds of derived units only a small number are frequently encountered in instructional materials. The ten major derived units are listed in the attached analyses. Other less frequently used ones are included in the column entitled, "Others". By listing the instructional units in the left-hand column it is possible to check off those base and derived units that are involved in each particular instructional unit.

Therefore, in the preparation of new instructional materials it is essential that the SI metric units must be included. How to include SI metric units in new

instructional materials in vocational-technical education is a problem that is not easily resolved. A meeting of textbook publishers held on the campus of Western Michigan University in the Spring of 1974 indicated that there was no general agreement among publishers as to how much metrics to include in the publications, and if some is to be included, how to include it. Some publishers believe that for the transitional period it will be necessary to include both the customary and the metric units wherever possible. This will mean that every time a length measurement is included in a textbook publication in inches, feet or yards, its equivalent in millimetres, centimetres or metres must be added. The general practice in this kind of dual arrangement is to include the customary unit first and the metric unit in parentheses directly behind it.

Others plan to include metrics in a separate section of the textbook so there would be, for example, several separate metric units on a particular area such as drafting, graphic arts, etc. In this case only pure SI metric measurement is taught with little or no conversion from one system to the next.

Regardless of the method of including SI metrics, the curriculum maker must have made an analysis of the instructional units to determine where SI metric units will be involved.

In preparing to produce the kits in the technical areas of GOING METRIC IN INDUSTRIAL EDUCATION, a careful analysis was made of how and where each of the base and derived units are involved in the instructional units in typical vocational courses. Analyses were made in drafting, general metals, machine shop, woodworking, residential building construction and graphic arts. These analyses formed the basis for developing the transparency masters and notes included in each of the packets. Packets of materials were organized into four major areas; namely GOING METRIC IN DRAFTING, GOING METRIC IN METALWORKING (which included both general metals and machine shop), GOING METRIC IN WOODWORKING (which included both woodworking and residential building construction) and GOING METRIC IN GRAPHIC ARTS. These same analyses could be used by curriculum makers in city, state and federal government to include the necessary metrics in the technical curriculum material developed. These analyses can also be used by professional personnel involved in writing performance objectives in various technical areas.

For example, Michigan recently spent a large sum of

money to develop performance objectives for all of the major technical areas taught in vocational and career education centers. However, the fact that the U.S. is steadily moving toward the SI measuring system was not taken into consideration when developing these performance objectives. If these performance objectives are to be valid in the years ahead, they must be revised to include SI metrics in all measurement activities. Textbook publishers must also be concerned with including the necessary SI metrics in each of the instructional units developed.

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Technical Sketching																
Geometric Shapes	X				X	X									rad	
Proportion	X				X											
Pictorial	X				X										rad	
Tools & Techniques																
Tools & Equipment	X	X	X	mol A cd s	X	X	X		X					X	rad	
Pencil Technique	X								X						rad	
Inking	X				X	X	X		X						rad	
Erasing									X							
Lines-Horizontal, Parallel, Incline, Vertical, Perp.	X								X						rad	

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Lettering	X								X						rad	
Drawing Papers	X	X			X	X										
Geometric Figures & Construction																
Geometric Shapes	X				X	X									rad	
Geometric Solids	X				X	X									rad	
Geometric Construction	X				X	X									rad	
Multiview Drawing																
Planes	X				X										rad	
Lines	X														rad	
Orthographic Projection	X				X	X									rad	

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Laying out Drawing	X				X	X									rad	
Projecting Curved Surfaces	X				X										rad	
Projecting Curved Edges	X														rad	
Intersection of Planes & Curved Surfaces	X				X										rad	
Rounds & Fillets	X														rad	
Conventional Break	X														rad	
Phantom Lines	X															
Dimensioning	X														rad	
Auxiliary Views																
Primary Auxiliary Views	X				X										rad	

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Secondary Auxiliary View	X				X										rad	
Descriptive Geometry																
Distance:																
Point to a Line	X														rad	
Between Parallel Lines	X														rad	
Angle Between Two Planes	X														rad	
Point Where Line Pierces a Plane	X				X										rad	
Intersection of Planes	X				X										rad	
Visibility	X														rad	
Revolution	X			s	X								X	X	rad	

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Pictorial Drawing																
Isometric	X				X	X									rad	
Oblique	X				X	X									rad	
Dimetric	X				X	X									rad	
Trimetric	X				X	X									rad	
Perspective	X				X	X									rad	
Special Applications																
Intersections	X				X										rad	
Gears & Cams	X	X		s	X	X		X	X	X	X	X	X	X	rad	
Vectors	X	X			X	X								X	rad	

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Detail & Assembly																
Pattern Detail	X		X		X										rad	
Machining Detail	X				X										rad	
Casting Detail	X														rad	
Forging Detail	X		X					X	X						rad	
Welding Detailing	X		X												rad	
Stamping Detail	X				X				X						rad	
Industrial Applications																
Aerospace Industry																
Aerodynamic Forces								X								

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Forming for Sheet Metal Parts	X		X		X	X		X	X						rad	
Technical Illustration	X				X										rad	
Structural Drawing																
Structural Steel																
Shapes	X														rad	
Rivets, High Strength Steel Bolts	X								X							
Welding	X		X						X							
Beam & Column Connections	X								X						rad	
Framing Drawings	X				X											
Erection Plan	X				X										rad	

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Exterior Walls, Beams, Columns, Trusses & Rigid Frames	X	X			X				X						rad	
Concrete Structures																
Reinforced Concrete	X				X				X						rad	
Engineering Drawings	X	X			X	X			X						rad	
Placing Drawings	X														rad	
Casting Structural Members	X				X	X									rad	
Wood Structures																
Wood Trusses	X	X			X				X						rad	
Laminated Wood Structural Members	X	X			X				X						rad	
Electrical/ Electronic Diagrams																

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Block Diagrams																
Schematic Diagrams																
Printed Circuit Drawings				A									X		rad	
Printed Circuit Layout				A									X		C V	
Industrial Controls				A							X		X		C V	
Electrical Power Fields				A									X		C V	
Mapping																
Scale	X				X											
Features on Maps	X				X											
Parallels & Mericians	X				X											

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Topographic Maps	X				X											
Contour Maps	X				X											
Profiles, Reliefs, Blocks	X				X											
Land Forms	X				X											
Nautical & Aeronautical Charts	X				X											
Aerial Mapping	X				X											
Land Survey	X				X											
Architectural Drawing																
Planning a House																
Building Site	X				X										rad	

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Floor Plan	X				X											
Individual Room Plan	X				X											
Exterior House Plan	X				X										rad	
Construction Details																
Footings/Foundations	X	X			X	X			X							
Frame Construction	X														rad	
Beams & Girders	X								X							
Outside Walls																
Insulation					X											
Partitions	X															

* INDICATE BY SYMBOL

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Finish Floors	X				X										rad	
Sills	X															
Brick Masonry	X				X				X							
Roof/Structural Openings																
Roof Coverings	X				X											
Cornice	X														rad	
Wood Trussed Roofs	X								X						rad	
Roof Ventilating																
Windows, Doors, Skylights	X				X											
Fireplaces	X															

Area: Drafting

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Stairs																
Support Members	X	X							X						rad	
Lighting & Wiring				A											C V	
Conditioned Air																
Plumbing	X	X				X	X		X						rad	
Perspective	X				X										rad	

70 * INDICATE BY SYMBOL

71

RESOURCES

DRAFTING

References:

1. Evans, Harry T., A Metric Engineering Drawing for Schools, London, England: George G. Harrap & Co., Ltd., 1971.

2. Feirer, John L. and Lindbeck, John R., Drawing and Planning for Industrial Arts, Peoria, Illinois: Chas. A. Bennett Company, Inc., 1975.

3. Heard, W. E., Geometrical Drawing for CSE, Metric Edition, Maidenhead, England: McGraw Hill Publishing Company, Ltd., 1969.

4. Lewis, A. W., Metric Technical Drawing, London, England: Methuen Educational, Ltd., 1973.

5. Center for Metric Education, Going Metric in Drafting, Western Michigan University, Kalamazoo, Michigan.

Area: General Metals

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Art Metal																
Layout	X	X			X	X										1, 2, 3
Principles of Measurement	X	X			X	X										1, 2, 3
Selecting Metals		X	X		X	X			X							1, 2, 3
Tapping, Chasing Design		X						X	X	X	X					1, 2
Basic Hand Tools								X	X	X	X					1, 2
Annealing			X	s												1, 2
Pickling			X	s			X									1, 2
Decorating a Surface								X	X	X	X					1, 2
Etching a Design			X	s			X									1, 2

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* INDICATE BY SYMBOL

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Area: General Metals

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Enameling			X	s			X									1, 2
Hard Soldering	X	X	X	s												1, 2
Polishing Coloring								X	X	X	X		X			1, 2
Metal Spinning	X	X			X	X		X	X	X	X		X			1, 2
Sheet Metal																
Using Mathematics	X	X			X	X	X									1, 2, 3
Principles of Measurement Tools	X	X			X	X	X									1, 2, 3
Basic Measuring & Layout	X	X			X	X	X	X	X							1, 2, 3, 4
Hand Tools								X	X	X	X		X			1, 2, 3
Cutting Sheet Metal	X	X			X	X	X	X								1, 2, 3

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* INDICATE BY SYMBOL

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Area: General Metals

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Bending	X	X			X	X	X	X								1, 2, 3
Angular Bends	X	X			X	X	X	X								1, 2, 3
Cylinders	X	X			X	X	X	X								1, 2, 3
Folds or Hems	X	X			X			X	X	X	X					1, 2, 3
Seams	X	X			X	X		X	X	X	X					1, 2, 3
Wiring an Edge	X	X			X	X		X	X	X	X					1, 2, 3
Beading	X	X			X	X		X	X	X	X					1, 2, 3
Crimping	X	X			X	X		X	X	X	X					1, 2, 3
Mechanics of Sheet Metal	X		X					X	X	X	X	X	X	X		1, 2, 3
Bench Shears	X	X			X	X		X	X	X	X					1, 2, 3

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Area: General Metals

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Pan Brakes	X	X			X	X		X	X	X	X					1, 2, 3
Bar Folder	X	X			X	X		X	X	X	X					1, 2, 3
Forming Rolls	X	X			X	X		X	X	X	X		X			1, 2, 3
Rotary Machine	X	X						X	X	X	X	X	X			1, 2, 3
Burring Rolls	X	X						X	X	X	X	X	X			1, 2, 3
Screws	X	X														1, 2, 3, 4
Rivets	X	X														1, 2, 3
Soldering (Soft)	X		X	s												1, 2, 3
Forging																
Hand Forging Equipment	X	X	X	s	X			X	X	X	X			X		1, 2, 3

* INDICATE BY SYMBOL

Area: General Metals

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Forge Fires			X	s												1, 2, 3
Tapering	X	X	X	s	X			X	X	X	X					1, 2, 3
Drawing Out	X	X	X	s	X			X	X	X	X					1, 2, 3
Bending	X	X	X	s	X			X	X	X	X					1, 2, 3
Twisting	X	X	X	s	X			X	X	X	X					1, 2, 3
Upsetting	X	X	X	s	X			X	X	X	X					1, 2, 3
Blackening Metal				s			X									1, 2, 3
Heat Treating																
Hardening			X	s	X			X	X	X	X					1, 2, 3
Tempering			X	s	X				X	X	X	X				1, 2, 3

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* INDICATE BY SYMBOL

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Area: General Metals

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Annealing			X	s	X				X	X	X	X				1, 2, 3
Casehardening			X	s	X				X	X	X	X				1, 2, 3
Foundry																
Pattern Making	X	X			X	X	X									1, 2, 3
Types of Casting	X	X														1, 2, 3
Molding Sands					X	X	X								kg/m^3	1, 2, 3
Selecting Foundry Metals	X	X	X	mol												1, 2, 3
Making a Mold	X	X			X	X		X	X	X	X					1, 2, 3
Pouring the Casting	X	X	X	s	X	X	X	X	X	X	X					1, 2, 3
Welding																

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* INDICATE BY SYMBOL

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Area: General Metals

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Gas Welding & Brazing				mol	X	X			X	X	X	X				1, 2
Equipment	X	X	X		X	X			X	X	X	X				1, 2
Rod & Fluxes	X	X	X													1, 2
Types of Welds	X	X	X		X	X										1, 2
Arc Welding	X	X	X	A					X	X	X	X				1, 2
Equipment	X	X	X		X	X			X	X	X	X				1, 2
Electrodes				A						X	X	X				1, 2
Types of Welds	X	X	X		X	X										1, 2

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* INDICATE BY SYMBOL

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References:

1. Feirer, John L., General Metals, New York: McGraw Hill Book Company, 1972.

2. Fraser, Roland R. and Bedell, Earl L., General Metals Principles, Procedures and Projects, Engelwood Cliffs, New Jersey: Prentice-Hall, Inc., 1962.

3. Giachion, J. W. and Schoenhals, Neil L., General Metals for Technology, Milwaukee, Wisconsin: The Bruce Publishing Company, 1964.

4. Center for Metric Education, Going Metric in Metalworking, Western Michigan University, Kalamazoo, Michigan.

Area: Machine Shop

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Basic Machine Tools	X	X		A, s	X	X				X	X	X	X			Ref. 1, 2, 3
Metal Cutting & Cutting Fluid	X		X		X	X	X	X	X	X	X	X	X			
Mechanics of Machines	X		X					X	X	X	X	X	X			FS-5, 6
Using Mathematics	X				X	X										
Selecting Metals	X	X	X													
Reading a Drawing	X															FS-3, 4
Cutting Off Stock to Length with Power Saw	X		X	s												
Principles of Measurement	X	X	X	mol, A cd, s			X									FS-1, 2
Basic Measuring Tools	X															Enlarged 3-D Metric Ruler Metric Rules
Using Calipers	X															

Area: Machine Shop

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Using & Reading a Micrometer	X															Enlarged 3-D Micrometer Types of Metric Micrometers
Using Vernier Tools	X															Enlarged 3-D Vernier 4 Types--Metric Verniers
Dial Indicating Gages	X															
Gage Blocks & Gaging	X															Metric Gage Block
Sine Bar & Angle Gage Block	X															
Making a Layout	X	X			X	X		X								
Cutting with a Hand Hack Saw	X	X		s				X	X	X	X					
Cutting with a Cold Chisel	X							X		X	X					
Filing, Broaching & Scraping	X							X	X	X	X					
Abrasives for Hand Polishing	X	X						X	X							

Area: Machine Shop

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Using a Bench or Pedestal Grinder	X			s				X	X		X	X	X			
Screw Thread & Thread Measuring	X				X	X										Ref. 4
Cutting Screw Threads with Taps & Dies	X							X	X	X	X	X				Metric Drills, Taps & Dies
Reaming at the Bench	X							X	X	X	X	X				Metric Reamers
Metal Fasteners & Tools for Assembly	X								X	X	X	X				Metric Fasteners & Wrenches
Safe Use of Hand Tools								X	X	X	X	X				Metric Tools
Band Machining Equipment	X	X	X	s, A	X	X	X	X	X	X	X	X	X	X		
Band Machining	X	X	X	s, A	X	X	X	X	X	X	X	X	X	X		
Types of Drilling Machines	X			s, A				X	X	X	X	X	X	X		
Twist Drills	X		X						X		X	X				Metric Drills

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* INDICATE BY SYMBOL

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Area: Machine Shop

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Drilling Holes in Flat Workpieces	X			s	X			X	X	X	X	X	X	X		
Drilling Holes in Round Workpieces	X					X										
Reaming in a Drill Press	X			s				X	X	X	X	X	X	X		Metric Reamers
Using Other Cutters in a Drill Press	X															Metric Taps
Drilling Machines in Industry	X															
Engine Lathes	X	X	X	s, A	X			X	X	X	X	X	X	X		Dual Reading Dials
Checking & Adjusting Lathes	X				X	X		X	X	X	X	X	X	X		
Cutting Tools & Toolholders	X	X	X		X	X		X	X	X	X				kg/m^3	Metric Inserts
Speed, Feed & Depth of Cut	X			s				X	X	X	X	X	X	X		
Locating & Drilling Holes	X	X														

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* INDICATE BY SYMBOL

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Area: Machine Shop

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Facing Ends with Workpiece in Center	X			s										X		
Rough Turning Between Centers	X	X		s	X			X	X	X	X	X		X		
Finish Turning Between Centers	X			s	X			X	X	X	X	X		X		
Turning Work to Two Diameters	X			s	X	X		X	X	X	X	X				
Installing a Chuck & Mounting Workpiece	X	X														
Facing, Turning & Cutting Off a Workpiece in a Chuck	X			s				X	X	X	X	X	X	X		
Drilling	X		X	s	X			X	X	X	X	X	X	X		
Boring	X							X	X	X	X	X	X	X		
Reaming	X							X	X	X	X	X		X		
Turning with Workpiece on a Mandrel	X							X	X	X	X	X	X			

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* INDICATE BY SYMBOL

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Area: Machine Shop

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Mounting a Workpiece in a Lathe Collet, Chuck or on Faceplate	X				X			X	X							
Knurling	X			s				X	X	X	X	X	X	X		
Filing & Polishing	X			s	X			X	X	X	X	X	X	X		
Taper Turning with a Taper Attachment	X			s				X	X	X	X	X	X	X		
Taper Turning & Cutting Angles with Compound Rest	X			s				X	X	X	X	X	X	X		
Turret Lathes	X	X		s, A												
Cutting External Threads	X							X	X	X	X	X	X	X		
Cutting Internal Threads	X							X	X	X	X	X	X	X		
Lathes in Industry	X															
Shaper	X	X			X	X		X	X	X	X	X	X	X		

Area: Machine Shop

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Checking & Adjusting Shapers	X							X	X	X	X	X	X	X		
Work Holding Devices	X	X			X	X		X	X	X	X	X				
Matching a Horizontal Surface	X							X	X			X				
Making a Vertical Cut	X							X	X							
Other Shaping Processes	X	X						X	X							
Shapers & Planers in Industry	X															
Milling Machines & Parts	X	X		A	X	X	X	X	X	X	X	X				
Milling Cutters & Cutter Holders	X			A	X			X	X	X	X	X				
Cutting Speeds, Feeds & Coolants	X			s	X								X	X		
Work Holding Devices & Their Uses	X				X			X	X			X				

100

* INDICATE BY SYMBOL

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Area: Machine Shop

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Milling a Flat Surface	X			s	X			X	X			X	X	X		
Face Milling	X			s	X			X	X	X	X	X	X	X		
Side Milling, Straddle Milling & Milling Slot or Keyseat	X			s	X			X	X	X	X	X	X	X		
Sawing, Slotting & Other Milling Operations	X				X											
Getting a Spur Gear	X				X											
Vertical Milling Machines	X	X		s, A	X	X	X	X	X	X	X	X	X	X		
Using a Vertical Milling Machine	X	X			X			X	X	X	X	X	X			
Milling Machines in Industry	X	X														
Abrasive Machines & Grinding	X	X			X	X		X	X	X	X					
Grinding Wheels	X	X			X	X		X	X	X	X					

Area: Machine Shop

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Surface Grinder	X	X		s, A	X	X	X	X	X	X	X		X	X		
Cylindrical Grinding	X	X		s, A												
Metals & Alloys	X	X	X													
Machinability of Steels					X	X		X	X						kg/m^3	
Heat Treatment & Testing	X	X	X		X	X		X	X							3-D Temperature Scale
Numerical Control	X															
Electrical Machining	X	X	X	s, A	X	X	X	X	X	X	X	X		X	kg/m^3	

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* INDICATE BY SYMBOL

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RESOURCES

MACHINE SHOP

References:

1. Feirer, John L., Machine Tool Metalworking, New York: McGraw Hill Book Company, 1973.

2. Holbrook, Horton, Machinery's Handbook, 19th Edition, New York: Industrial Press, Inc., 1971.

3. A Metrication Board Manual, Metrication in the Machine Shop, London: Her Majesty's Stationery Office, 1971.

4. Industrial Fasteners Institute, A Study to Develop an Optimum Metric Fastener System, Ohio, 1974.

Filmstrips and Cassettes:

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FS-1 Introduction to the Metric System
FS-2 Basic and Derived Units
FS-3 Linear Measurement and Precision Instruments
FS-4 Geometric Dimensioning and Tolerancing
FS-5 Science and Metrics--Part 1
FS-6 Science and Metrics--Part 2

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Kinds of Woods	X	X	X	cd	X	X					X				kg/m^3	Ref. 1
Properties of Wood	X	X	X	A	X	X		X	X	X	X			X	kg/m^3	
Nature of Wood	X	X	X		X	X	X	X	X		X			X	kg/m^3	
Seasonry	X	X	X		X		X	X	X		X					
Grading Lumber	X				X						X					
Buying Lumber	X				X						X					
Plywood & Veneer	X	X	X		X	X	X	X	X		X		X		kg/m^3	
Modified Woods	X	X	X		X		X	X	X				X		kg/m^3	
Wood Science	X	X	X	s A	X	X	X	X	X	X	X	X	X	X	kg/m^3	FS. 5, 6
Layout & Measuring	X			mol	X				X							FS. 3

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Hand Sawing Tools	X	X			X			X						X	kg/m^3	Ref. 1
Edge Cutting Tools	X		X		X			X						X	kg/m^3	Ref. 1
Drilling & Boring	X		X						X		X	X				Ref. 1
Tool Sharpening	X		X		X			X	X				X	X	kg/m^3	Ref. 1
Machine Principles	X	X	X	A cd s	X		X	X	X	X	X	X	X	X	kg/m^3	Ref. 1
Radial Arm Saw	X	X	X	A cd s	X			X	X	X	X	X	X	X	kg/m^3	Ref. 1
Cross Cutting	X			A s	X			X		X	X	X	X	X	kg/m^3	Ref. 1
Ripping	X			s	X			X		X	X	X	X	X	kg/m^3	Ref. 1
Special Applications	X				X			X		X	X	X	X	X	kg/m^3	Ref. 1
Planer	X	X	X	A cd s	X			X	X	X	X	X	X	X	kg/m^3	Ref. 1

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* INDICATE BY SYMBOL

110

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Circular Saw	X	X	X	A cd s	X			X	X	X	X	X	X	X	kg/m^3	Ref. 1
Ripping	X				X			X					X	X	kg/m^3	
Cross Cutting	X				X			X					X	X	kg/m^3	
Dado Head	X				X			X					X	X	kg/m^3	
Miters	X				X			X					X	X	kg/m^3	
Special Applications	X				X			X					X	X	kg/m^3	
Band Saw	X	X	X	A cd s	X			X	X	X	X	X	X	X	kg/m^3	
Free Hand	X				X			X					X	X	kg/m^3	
Guided	X				X			X					X	X	kg/m^3	
Compound	X				X			X					X	X	kg/m^3	

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INDICATE BY SYMBOL

112

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Scroll Saw	X	X	X	A cd s	X		X		X	X	X	X	X	X	kg/m^3	
Free Hand Out	X		X	s	X			X			X	X	X	X	kg/m^3	Ref. 1
Free Hand In	X		X	s	X			X			X	X	X	X	kg/m^3	
Guided	X		X	s	X			X			X	X	X	X	kg/m^3	
Jointer	X	X	X	A cd s	X		X		X	X	X	X	X	X	kg/m^3	
Surface Work	X			s	X			X			X	X	X	X	kg/m^3	Ref. 1
Edge Work	X			s	X			X			X	X	X	X	kg/m^3	Ref. 1
Square Corners	X			s	X			X			X	X	X	X	kg/m^3	Ref. 1
Special Work	X			s	X			X			X	X	X	X	kg/m^3	Ref. 1
Shaper	X	X	X	A cd s	X			X	X	X	X	X	X	X	kg/m^3	

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Full Edge	X			s A				X			X	X	X	X		Ref. 1
Partial Edge	X			s A				X			X	X	X	X		
Straight	X			s A				X			X	X	X	X		
Irregular	X			s A				X			X	X	X	X		
Pattern Work	X							X			X	X	X	X		
Mortises	X	X	X	cd s	X			X	X	X	X	X	X	X	kg/m^3	Ref. 1
Hollow Chisel	X		X		X			X			X	X	X	X	kg/m^3	
Chain	X		X		X			X			X	X	X	X	kg/m^3	
Bit	X		X		X			X			X	X	X	X	kg/m^3	
Drill Press			X													FS. 1, 2, 3

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* INDICATE BY SYMBOL

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED												Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.		
Bits	X		X		X												
Drills	X		X		X												
Plugs	X		X		X												
Hole Saws	X		X		X												
Speeds	X		X	s A				X	X	X	X	X	X	X			
Wood Lathe																	FS. 1, 2, 3
Spindle	X		X		X			X	X	X	X	X	X	X			
Face Plate	X		X		X			X	X	X	X	X	X	X			
Chucks	X		X		X			X	X	X	X	X	X	X			
Joinery																	FS. 1, 2

117

* INDICATE BY SYMBOL

118

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Squaring	X			A	X			X					X	X		
Kinds of Joints	X	X														
Construction of Joints	X	X		A	X	X		X					X	X		
Adhesives																
Kinds of		X	X			X	X								kg/m^3	
Application	X		X		X	X	X						X	X		
Gluing																
Clamps	X		X		X			X	X	X						
Special Types	X							X	X	X			X	X		
Wood Fasteners																FS. 1, 2

119

* INDICATE BY SYMBOL

120

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED												Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.		
Nails	X	X			X			X	X								
Screws	X	X			X			X	X								
Bolts	X	X			X			X	X								
Brads & Wire Nails	X	X			X			X	X								
Special Types	X	X			X			X	X								
Laminating & Bending	X	X	X		X	X	X	X	X		X				kg/m^3		
Abrasives																	
Manufacture	X	X	X		X	X				X	X		X	X	kg/m^3		
Types	X	X				X											
Uses	X		X		X			X	X								

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* INDICATE BY SYMBOL

122

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Sanding Machines																
Machine	X	X	X	A			X	X	X		X		X	X		
Portable	X	X	X	A				X	X		X		X	X		
Hardware																
Hinges	X				X											
Catches	X															
Pulls	X				X											
Others	X													X		
Cabinetmaking																FS. 1, 2, 3
Case Goods	X	X	X		X	X		X	X							

123

* INDICATE BY SYMBOL

124

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Kitchen	X	X	X		X	X	X	X	X							
Furniture	X	X	X		X	X		X	X							
Patternmaking	X	X	X		X	X	X	X	X			X	X	X		FS. 1, 2, 3
Boat Building	X	X	X		X	X	X	X	X							FS. 1, 2, 3
Finishing																
Paints		X	X		X	X	X								kg/m^3	
Lacquer & Varnish		X	X		X	X	X								kg/m^3	
Penetrating Finishes		X	X		X	X	X								kg/m^3	
Brushes			X		X	X	X									Brush Care Kit
Spray		X	X	cd	X	X	X		X		X				kg/m^3	

* INDICATE BY SYMBOL

Area: Woodworking

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Stains & Glazes		X	X		X	X	X									
Upholstery																FS. 3
Springs & Stuffing	X	X			X			X								
Fabrics	X			cd	X											
Styles	X	X			X			X								
Sewing	X				X	X		X			X	X	X	X		
Material Testing	X	X	X	A cd s	X	X	X	X	X	X	X	X	X	X	kg/m^3	FS. 1, 2

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* INDICATE BY SYMBOL

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RESOURCES

WOODWORKING

References:

1. Feirer, John L., Machine Tool Metalworking, New York: McGraw Hill Book Company, 1973.

2. Holbrook, Horton, Machinery's Handbook, 19th Edition, New York: Industrial Press, Inc., 1971.

3. A Metrication Board Manual, Metrication in the Machine Shop, London: Her Majesty's Stationery Office, 1971.

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FS-5 Science and Metrics--Part 1
FS-6 Science and Metrics--Part 2

Area: Residential Building Construction SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Planning	X	X	X	A	X	X	X	X	X						kg/m^3	Fs 1, 2 & 3
Reading Prints	X	X	X		X	X	X	X	X							Fs 1, 2 & 3
Materials																
Woods	X	X			X	X		X	X							
Plywood	X				X											
Particle Board	X				X											
Hardboard	X				X											
Others	X				X											
Tools & Machines	X	X	X	A	X	X			X		X			X		
Safety	X	X	X		X	X			X					X		

Area: Residential Building Construction SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Hand Tools	X															
Foundations																
Location	X	X			X	X		X	X							
Scaffolds & Ladders	X	X						X	X							
Concrete & Footings	X	X	X		X	X	X	X	X						kg/m^3	
Poured Walls	X	X	X		X	X	X	X	X						kg/m^3	
Block Walls	X	X	X		X	X	X	X	X						kg/m^3	
Concrete Flat Work	X	X	X		X	X	X	X	X						kg/m^3	
Framing																
Methods	X	X			X	X		X	X							

Area: Residential Building Construction SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Floors	X	X	X	s	X	X	X	X	X						kg/m^3	
Walls	X	X	X	s	X	X	X	X	X						kg/m^3	
Wall Sheathing	X	X	X	s	X				X						kg/m^3	
Ceilings	X	X	X	s	X										kg/m^3	
Roofs	X	X	X	s	X	X			X						kg/m^3	Metric Steel Square
Rafters	X	X	X	s	X	X			X						kg/m^3	Metric Steel Square
Hip & Valley	X	X		s	X										kg/m^3	Metric Steel Square
Jack Rafters	X	X		s	X										kg/m^3	Metric Steel Square
Layout	X				X											Metric Steel Square
Trusses	X	X	X	s	X			X	X						kg/m^3	Metric Steel Square

Area: Residential Building Construction SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Roof Sheathing	X	X	X		X				X							
Roof Covering	X	X	X		X									X		
Exterior																
Roof Trim	X															
Windows	X	X	X	cd	X				X					X		
Doors & Frames	X	X		s	X									X	kg/m^3	
Wall Coverings	X	X	X	s	X			X					X		kg/m^3	
Interior																
Insulation	X	X	X	s	X	X									kg/m^3	
Vapor Barriers	X	X	X		X											

* INDICATE BY SYMBOL

Area: Residential Building Construction SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Sound Insulation	X	X	X	s	X								X		kg/m^3	
Wall & Ceiling Finishing	X	X	X	s	X										kg/m^3	
Flooring	X	X	X	s	X				X						kg/m^3	
Stairs	X	X	X	s	X											Metric Steel Square
Cabinets	X	X	X		X	X	X									
Interior Trim	X	X			X										kg/m^3	
Painting & Finishing																
Interior	X	X	X	cd s	X	X	X		X		X			X	kg/m^3	
Exterior	X	X	X	cd s	X	X	X		X		X			X	kg/m^3	
Paint Problems	X	X	X	cd s	X	X	X		X		X			X	kg/m^3	

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* INDICATE BY SYMBOL

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Area: Residential Building Construction SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Related Activities																
Chimneys & Fireplaces	X	X	X	cd A s	X	X					X		X			
Decay & Termites	X	X	X	cd s	X	X	X		X					X		
Ventilation	X		X	A s	X	X					X		X	X		
Scheduling	X	X	X	s	X	X										
Manufacturing Housing	X	X	X	cd A s	X	X			X					X		
Recreation Vehicles	X	X	X	cd A s	X	X			X		X			X		
Model Construction	X	X	X	cd A s	X	X									kg/m^3	
Climate Control	X	X	X	A	X	X	X	X	X		X			X	kg/m^3	
Electrical	X	X	X	cd A s					X		X		X	X		

140

* INDICATE BY SYMBOL

141

Area: Residential Building Construction

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Brick & Stone Work	X	X	X		X	X	X	X								
Plumbing	X		X				X		X							
Sound Systems	X			A							X		X			

RESOURCES

RESIDENTIAL BUILDING CONSTRUCTION

References:

1. Feirer, John L., Machine Tool Metalworking, New York: McGraw Hill Book Company, 1971.

2. Holbrook, Horton, Machinery's Handbook, 19th Edition, New York: Industrial Press, Inc., 1971.

3. A Metrication Board Manual, Metrication in the Machine Shop, London: Her Majesty's Stationery Office, 1971.

4. Industrial Fasteners Institute, A Study to Develop an Optimum Metric Fastener System, Ohio, 1974.

Filmstrips and Cassettes:

From Uniten Systems, Inc., 246 West 34th Street, Indianapolis, Indiana 46208

FS-1 Introduction to the Metric System
FS-2 Basic and Derived Units
FS-3 Linear Measurement and Precision Instruments
FS-4 Geometric Dimensioning and Tolerancing
FS-5 Science and Metrics--Part 1
FS-6 Science and Metrics--Part 2

Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Composition Methods																
Foundry Type	X															Ref. 1
Hot Metal	X		X													Ref. 1
Impact	X							X								Ref. 1
Dry Transfer	X								X							Ref. 1
Hand Mechanical	X															Ref. 1
Photographic	X															Ref. 1
Computer-Aided	X		X													Ref. 1
Copy Preparation																
Equipment	X		X	s			X		X							

145

* INDICATE BY SYMBOL

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Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Copy Consideration	X				X											
Cropping, Scaling, Register Marks	X				X											
Paste-Up	X		X			X	X		X							
Copy Division, Multi-color Reproduction	X			cd	X										rad	
Process Camera																
Classification of	X															Ref. 1
Horizontal	X			cd	X											Ref. 1
Vertical	X			cd	X											Ref. 1
Films	X		X	cd					X							Ref. 1
Chemicals		X				X	X									Ref. 1

147

* INDICATE BY SYMBOL

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Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED												Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols *. kg/m^3, etc.		
Adjust the Camera	X			s	X											rad	Ref. 1
Scaling	X				X												Ref. 1
Basic Exposure				s													Ref. 1
Darkroom Procedure																	
Equipment	X		X	cd s		X											Ref. 1
Exposing Film	X		X	cd s													Ref. 1
Develop Film	X		X	cd s		X	X										Ref. 1
Mixing Chemicals			X			X	X										Ref. 1
Layout of Darkroom	X			cd	X												Ref. 1
Letter Press Image Carriers																	

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Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Photo Engravings	X			A cd s			X									Ref. 1
Non-metallic Photo Sensitive	X			cd s	X		X									Ref. 1
Electronic Engraving	X			A cd s												Ref. 1
Stereotypes	X		X	s			X		X				X			Ref. 1
Electrotypes	X		X	s			X		X							Ref. 1
Rubber & Thermoplastic	X		X	s	X											Ref. 1
Linoleum Block	X				X			X	X							Ref. 1
Letterpress Lock-Up & Imposition																
Tools & Equipment	X				X				X							
Kinds of Lock-Up	X				X				X							

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152

Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Multiple Page Lock-Up & Imposition	X				X				X							
Slug Cutting	X								X				X			
Letterpress Image Transfer																
Flexography	X		X	s					X				X			Ref. 1
Platen Press Preparation	X						X		X				X			Ref. 1
Cylinder Press Preparation	X			s			X		X				X			Ref. 1
Lithographic Image Transfer																
Lithography	X						X									Ref. 1
Offset Lithography Press	X				X		X		X				X			
Lithographic Image Carriers																

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154

* INDICATE BY SYMBOL

Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Direct Image Plates	X								X							Ref. 1
Exposing Presensitized Plates	X			cd, s												Ref. 1
Processing Presensitized Plates	X		X				X		X							Ref. 1
Preserving & Storing Plates			X				X									Ref. 1
One Step Photographic Plates	X			s			X									Ref. 1
Lithographic Imposition																
Tools & Materials of the Striper	X			cd												Ref. 1
Preparation & Layout for Striping	X			cd												Ref. 1
Attaching Neg's to Masking Sheet	X			cd					X							Ref. 1
Cutting Windows & Opaquing	X			cd			x		x							Ref. 1

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Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Multiple Striping	X			cd			X		X							Ref. 1
Gravure Printing Process																
Image Carriers	X			cd, s												Ref. 1
Gravure Printing Presses	X						X						X			Ref. 1
Etching & Engraving	X			cd			X									Ref. 1
Hand Engraving & Printing	X				X		X		X							Ref. 1
Thermography	X		X		X											Ref. 1
Screen Printing																
Industrial Equipment	X		X		X		X		X				X			Ref. 1

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Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Hand Equipment	X				X		X		X							Ref. 1
Press Construction	X				X				X							Ref. 1
Film	X			cd	X		X		X							Ref. 1
Masking	X				X				X							Ref. 1
Printing Operation							X		X							Ref. 1
Multicolor Process	X				X		X		X							Ref. 1
Photography																
Kinds of Cameras	X			cd												Ref. 1
Proper Exposure				cd, s										X		Ref. 1
Films & Papers	X		X	cd, s												Ref. 1

Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Film Development	X		X	cd, s			X									Ref. 1
Contact Printing	X		X	cd, s	X		X									Ref. 1
Projection Printing	X		X	cd, s	X											Ref. 1
Finishing & Mounting	X		X		X				X							Ref. 1
Limited Copy Duplication Methods																
Spirit	X				X		X		X				X			Ref. 1
Mimeograph	X			cd	X		X		X							Ref. 1
Silver Halide (Copier)	X			cd	X									X		Ref. 1
Thermo-graphic	X		X	cd, s	X									X		Ref. 1
Thermo-electrostatic	X			cd, s	X									X		Ref. 1

Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Direct-electrostatic	X			A, s	X									X		Ref. 1
Binding Methods																
Soft Cover	X							X	X							Ref. 1
Post Binding	X		X	s		X	X	X	X							Ref. 2
Wire Stitching	X							X	X							Ref. 2
Perfect (Hand)	X		X	s		X	X	X	X							Ref. 2
Case (Hand)	X		X	s		X	X	X	X							Ref. 2
Finishing Methods																
Paper Cutting	X			s					X							Ref. 1
Folding	X							X	X							Ref. 1

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* INDICATE BY SYMBOL

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Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED												Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.		
Scoring	X							X	X								Ref. 1
Perforating	X							X	X								Ref. 1
Gathering																	Ref. 1
Punching & Drilling	X							X	X								Ref. 1
Die Cutting	X							X	X								Ref. 1
Hot Stamping	X		X					X	X								Ref. 1
Laminating	X		X					X	X								Ref. 1
Pulp & Paper Manufacturing																	
Pulp Manufacturing	X		X	s		X	X		X							rad	Ref. 1
Paper Manufacturing	X		X		X				X					X			Ref. 2

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* INDICATE BY SYMBOL

Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Kinds of Paper	X	X														Ref. 2
Size & Weight of Paper	X	X														Ref. 2
Cost & Purchasing Paper	X	X														Ref. 2
Printing Inks																
Composition			X	s		X	X									Ref. 1
Manufacture			X	s		X	X		X		X					Ref. 1
Planning, Designing & Layout																
The Point	X				X											Ref. 1
Design Principles	X			cd	X											Ref. 1
Thumbnail Sketches	X				X											Ref. 1

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
Rough Layout	X				X											Ref. 1
Comprehensive Layout	X				X											Ref. 1
Page & Signature Layout	X				X				X							
Machines																
Paper Cutter	X			s					X							Ref. 1
Slug Cutter	X								X							Ref. 1
Paper Drill	X								X							Ref. 1
Staple Machine	X								X							Ref. 1
Trim Saw	X												X			Ref. 1
Platen Press	X												X			Ref. 1

Area: Graphic Arts

SI METRIC

Instructional Units	BASE				DERIVED											Instructional Technology 3-D, Visuals, Tools, etc.
	Length - Metre	Mass - kilogram	Temperature - degree Celsius	Others - use symbols * s - A - cd - mol	Area - m^2	Volume - m^3	Liquid Capacity - litre	Force - N	Pressure & Stress - Pa	Energy - J	Power - W	Torque - N·m	Frequency - Hz	Speed - m/s	Others - use symbols * kg/m^3, etc.	
A. B. Dick	X					X	X						X			Ref. 1
Chief 20	X					X	X						X			Ref. 1
Chief 15	X					X	X						X			Ref. 1
Multilith 1250	X					X	X						X			Ref. 1

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RESOURCES

GRAPHIC ARTS

References:

1. Cameron, Clive A., Going Metric with the U.S. printing Industry, Rochester: Graphic Arts Research Center, 1972.

2. Center for Metric Education, Going Metric in Graphic Arts, Western Michigan University, Kalamazoo, Michigan.

Section 3

Part B

SURVEYS

When the federally funded project, Metrication of Technical Career Education, was funded in 1972, it was the first project of its type in the United States. Therefore, the Directors faced several major problems in collecting background information and materials to develop the instructional kits. These included:

1. It was decided early to develop a library, which would include written instructional material, audio-visual material and three-dimensional learning devices, and tools all in metric. At the time it was difficult to secure any of these materials in the United States since metrics was of limited concern in 1972. At the time there was little published in the way of written instructional materials or audio-visual aids. Most of the volume of material produced have come on the market since 1972. A major source of metric materials in 1972 was from countries who were well along in their metric conversion programs; namely England and South Africa. However, it was difficult and time-consuming to secure materials from these sources. The average time frame to obtain materials was from five weeks to three months. However, efforts were made to secure as much material as possible.

2. In 1972 little was known about the status of metric conversion in the United States since there was no organization or central information collecting agency operating at that time. Since that time both the American National Metric Council and the Metric Information Center at the National Bureau of Standards have been established to provide many of these functions.

3. The Center had to depend on the advice of its Advisory Board to determine the status of industrial activities dealing with metric conversion. The majority of the Advisory Board members represented major multinational corporations who were in the early planning stages of metric conversion in 1972.

4. It was difficult, if not impossible, to know what was going on among industry and organization. At the time there were no national reporting services, no metric magazines and no other direct sources of information. An attempt to determine to some extent the status

of metric conversion was made in 1972. Three surveys were sent to three different groups during the fall of 1972 and in early 1973.

The first survey (Figure 3B-1) was sent to a list of eighty-eight professional organizations that the Center thought would be concerned with metric conversion for their particular segment of industry. The survey was sent to eighty-eight of the approximate three hundred professional and trade organizations and associations. As might be expected, the results of this survey were rather discouraging since at the time few of these organizations were stimulated or interested in metric conversion. As a result, only seventeen of the eighty-eight organizations surveyed returned their form for a percentage of answers of nineteen. Fifty-three percent of the organizations indicated that they had or were engaged in some type of metrication program. None of the organizations, however, had secured any funding. Therefore, the level of activity was relatively low.

None of the organizations indicated a willingness to provide additional funding to the Center for Metric Education for development and dissemination of metric materials. Sixty-five percent of them indicated that they would be willing to help in an advisory capacity. The most common comment from these organizations was that they were only now beginning to think about the problems of metric conversion for their particular organization.

The first step in metric conversion in industry involves the redesigning of equipment. Therefore, the drafting room is the first area of the company that must be concerned with metric conversion. In preparation of developing the kit entitled, GOING METRIC IN DRAFTING, a survey was sent to approximately eighty companies who produce drafting equipment. Figure 3B-2. This survey indicated that in 1972 only nineteen out of the eighty companies were concerned enough with metric conversion to return the survey.

It can be assumed that the great majority of companies had not been motivated to begin to convert their drafting equipment to metrics. Fifteen out of the twenty-four companies that answered indicated that they were manufacturing metric drafting equipment including scales, templates, etc. However, only two indicated that they had other materials in metrics available such as ISO paper sizes. A complete summary of all of the answers are included in Figure 3B-3.

Since the purpose of this project was to develop instructional material in the area of vocational and technical education, it seemed appropriate that a survey be made of the fifty state superintendents of public instruction to determine what plans they had for metric conversion. This survey was done during the period of April to June, 1973. Figure 3B-4. The response to this survey clearly pointed up the fact that in early 1973 superintendents of public instruction had given little thought to what metric conversion would mean to American education. Only five of the fifty state superintendents indicated that they had made any plans whatsoever for metric conversion. Since early 1973 a great many states have made commitments to metric conversion. However, few states have really implemented metric conversion for their school systems. If metric conversion is to be effective in any state it requires that:

1. Teacher education be changed to include metrics for all preservice teachers.
2. Inservice workshops must be held for all teachers in the state to orient them to SI metrics and to provide them with the necessary background to include metrics in their instructional programs.
3. Instructional materials must be changed to include SI metrics. To date, no state has made real progress in achieving the goal of metric conversion in all of its educational programs from kindergarten through teacher education. Until there is an organized state effort for metric conversion, education will fall behind industry in metric conversion activities.

Figure 3B-1

Center For Metric Education

Gentlemen:

We recently received a Federal Grant to establish a Center for Metric Education at Western Michigan University. Our primary function this first year is to produce instructional materials for career education programs, such as industrial-technical education, home economics, etc. As a first step toward achieving this goal, we are trying to ascertain how many professional organizations and industries are presently involved in metrication. Would you, therefore, assist us by responding to this short questionnaire and returning it to us immediately. We will appreciate your cooperation.

Sincerely,

John L. Feirer, Director

John R. Lindbeck, Co-Director

	Yes	No
1. Is your organization now engaged in a metrication program?		

2. If yes to above, what specifically are you doing? (check)

retraining staff	
publishing bulletins	
operating in-service programs	
purchasing metric tools and equipment	

other (specify): _____

3. If no to question 1, when do you anticipate beginning? (date) _____

4. Do you have one person who is responsible for the metric program? ☐☐

Name _____

5. What published materials do you use in your program?

_____

_____

_____

Can we get copies of this material? ☐☐

Please indicate their cost: _____

	Financial		Counsel	
6. Would you be willing to cooperate with funding or advising for our project?	Yes	No	Yes	No

7. Additional questions or comments: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

USE NUMBER 2 PENCIL ONLY
PRINT ALL LETTERS

Figure 3B-2

Center For Metric Education

Gentlemen:

We recently received a Federal Grant to establish a Center for Metric Education at Western Michigan University. Our primary function this first year is to produce instructional materials for career education programs, such as industrial-technical education, home economics, etc. As a first step toward achieving this goal, we are trying to ascertain how many suppliers of drafting aids, instruments, or media are presently involved in metrication. Would you, therefore, assist us by responding to this short questionnaire and returning it to us immediately. We would also appreciate receiving any catalogs available on metric drafting materials. We will appreciate your cooperation.

Sincerely,

John L. Feirer

John L. Feirer, Director

1. Is your company now manufacturing metric drafting aids, instruments, or media? Yes ☐ No ☐

2. If no to above, do you plan to manufacture and supply metric materials of this nature in the future? ☐

   If yes, at what future date? _____

3. If yes to questions 1 or 2, what specifically are you planning to supply? (check the following) ☐

   A. Scales

   Ratio of:

	Yes	No		Yes	No		Yes	No
1:1	☐	☐	1:10	☐	☐	1:1250	☐	☐
1:2	☐	☐	1:20	☐	☐	1:2500	☐	☐
1:5	☐	☐	1:50	☐	☐	Other	☐	☐

   If other, specify _____

   B. Templates ☐

   Types:

	Yes	No		Yes	No
circle	☐	☐	hexagon nuts and bolts	☐	☐
ellipse	☐	☐	screw thread	☐	☐
isometric	☐	☐	radius guide	☐	☐
square	☐	☐	other	☐	☐

   If other, specify _____

   C. ISO paper (International Organization for Standardization) ☐

   Sizes in mm:

	Yes	No		Yes	No
A0 1,189 x 841	☐	☐	A4 297 x 210	☐	☐
A1 841 x 594	☐	☐	A5 210 x 148	☐	☐
A2 594 x 420	☐	☐	A6 148 x 105	☐	☐
A3 420 x 297	☐	☐	Other	☐	☐

   If other, specify _____

   D. Grid paper (rectilinear) ☐

100 mm grid				300 mm grid			
Ratio	Yes	No	Paper Size	Ratio	Yes	No	Paper Size
1:20	☐	☐	_____	1:20	☐	☐	_____
1:50	☐	☐	_____	1:50	☐	☐	_____
1:100	☐	☐	_____	1:100	☐	☐	_____

   Other (specify): _____

4. Are additional metric materials available? ☐

_____

_____

_____

_____

Figure 3B-3

Center For Metric Education

Gentlemen:

We recently received a Federal Grant to establish a Center for Metric Education at Western Michigan University. Our primary function this first year is to produce instructional materials for career education programs, such as industrial-technical education, home economics, etc. As a first step toward achieving this goal, we are trying to ascertain how many suppliers of drafting aids, instruments, or media are presently involved in metrication. Would you, therefore, assist us by responding to this short questionnaire and returning it to us immediately. We would also appreciate receiving any catalogs available on metric drafting materials. We will appreciate your cooperation.

Sincerely,

John L. Feirer, Director

	Yes	No
1. Is your company now manufacturing metric drafting aids, instruments, or media?	15	9
2. If no to above, do you plan to manufacture and supply metric materials of this nature in the future?	5	4

If yes, at what future date? _____

3. If yes to questions 1 or 2, what specifically are you planning to supply? (check the following) 11 5

A. Scales

Ratio of:

	Yes	No		Yes	No		Yes	No
1:1	10		1:10	7	2	1:1250	4	3
1:2	7	1	1:20	8	1	1:2500	5	3
1:5	8	1	1:50	8	1	Other	7	

If other, specify _____

B. Templates 8 11

Types:

	Yes	No		Yes	No
circle	6		hexagon nuts and bolts	4	1
ellipse	4	1	screw thread	4	1
isometric	4	1	radius guide	4	1
square	4	1	other	5	1

If other, specify _____

C. ISO paper (International Organization for Standardization) 2 17

Sizes in mm:

	Yes	No		Yes	No
A0 1,189 x 841	1		A4 297 x 210	1	
A1 841 x 594	1		A5 210 x 148	1	
A2 594 x 420	1		A6 148 x 105	1	
A3 420 x 297	1		Other	1	

If other, specify _____

D. Grid paper (translucent) 3 16

100 mm grid				300 mm grid			
Ratio	Yes	No	Paper Size	Ratio	Yes	No	Paper Size
1:20	2	1		1:20	1	2	
1:50	2	1		1:50	1	2	
1:100	2	1		1:100	2	1	

Other (specify): _____

4. Are additional metric materials available? 4 16

_____

_____

_____

_____

Figure 3B-4

CENTER FOR METRIC EDUCATION

Yes	No

1. Do you have plans to introduce metric measurement into your state system?

   If yes, what are the dates for:

   elementary, fall of _____
   secondary, fall of _____
   vocational, fall of _____
   technical, fall of _____

2. If you are planning to introduce the metric system of measurement, could you answer the following questions?

   a. Has your staff determined such basics as spelling (metre or meter) and pronunciation (ki-lom'-e-tre or kill'-o-metre)? ☐ ☐

   b. Has your staff discussed the way in which you will handle the mass/weight dilemma; i.e., if kilograms are to be used both for mass and weight, at what point will your state introduce newton as the unit of force? ☐ ☐

   c. Do you have plans for introducing international standards (ISO) when appropriate; for example, paper sizes, ISO metric threads, etc. ☐ ☐

3. Are you planning a series of in-service seminars for teachers? ☐ ☐

4. If yes to question #3, when will the first seminar be offered?

   _____

5. Comments: _____

Section 3

Part C

USE OF ADVISORY COMMITTEE

The basic premise for good vocational-technical education is that there should be an advisory committee for each occupation or curriculum area. Since the world of work is a dynamic whirlpool of change, it is extremely important to have individuals represented on the advisory board committee that are actively interested in and knowledgeable of the curriculum area.

When Western Michigan University was given the grant for the U.S.O.E. sponsored project, number V257006, to develop instructional materials in metrics, it was immediately clear that a talented and knowledgeable advisory committee would be needed if the materials that were to be developed would be valid. In fact, this was the only way the professional personnel on the staff of the Center could obtain valid advice on what was to go into each of the curriculum packets that they were planning to develop.

In 1972 vocational-technical programs along with most of American education had not recognized that metric conversion was on the horizon and would be a major factor in curriculum development in the years ahead. The only individuals who were cognizant of the developments in metric were those persons responsible for standards with companies that were multinational in nature. These companies were the first to recognize the need to convert to the metric system of measurement. It was, therefore, apparent that one of the first steps that needed to be accomplished was to collect an advisory committee.

It was decided to use basic pert principles in organizing and controlling the metric project. The steps to be included were the following:

1. Complete decision on size and character of advisory committee.
2. Start search in the occupational area for advisory committee candidates.
3. Complete search in the occupational area for advisory committee candidates.
4. Start search in the community for advisory commitee candidates.

5. Complete search in the community for advisory committee candidates.
6. Complete list of prospective advisory committee candidates.
7. Complete check of prospective advisory committee candidate list by president.
8. Complete final check of advisory committee candidates to see if they are still interested in serving.
9. Complete securing supervisor's approval.
10. Start personal data forms on advisory committee candidates.
11. Complete personal data forms on advisory committee candidates.
12. Complete board of trustees' approval of advisory committee candidates.
13. Complete president and board of trustees' calendar check for date of first advisory committee meeting.
14. Complete sending of appointment letters.
15. Start orientation for advisory committee members.
16. Complete orientation for advisory committee members.
17. Start work on agenda of first advisory committee meeting.
18. Complete agenda of first advisory committee meeting.
19. Complete decision on the date, time and place of first meeting.
20. Complete sending announcements of first meeting.
21. Start meeting.
22. Complete meeting.
23. Complete revision and evaluation of meeting.
24. Complete giving advisory committee recommendations of college administration for action.
25. Complete distribution of minutes to leaders of the college.
26. Complete news media notification regarding advisory committee recommendations.
27. Start writing advisory committee handbook.
28. Complete writing advisory committee handbook.
29. Start securing materials from institutions having existing programs in occupational area.
30. Complete securing materials from institutions having existing programs in occupational area.
31. Project end.

Using this as the overall plan, the first step was to complete a decision on the size and character of the advisory committee. It was decided that each individual on the advisory committee should represent one of the technical areas, drafting, woods, metals, and so forth, in which instructional material was to be developed. It

was also decided that the individuals should be the best qualified people in the United States. The only limitation in selecting this advisory committee was that when possible, persons who were selected were within a reasonable distance of Kalamazoo, Michigan. Since there were no funds for the advisory committee, it was necessary for each of these individuals to serve free of charge based largely on their interest in metric measurement.

Early in July, 1972, contacts were made with a number of individuals who were knowledgeable in metrics and who could bring to the Center the expertise needed to evaluate the instructional material that was to be developed. In addition to the group from industry, it was decided to have at least one representative from the National Bureau of Standards--U.S. Department of Commerce since this was the group responsible for preparing the three-year study, A METRIC AMERICA--A DECISION WHOSE TIME HAS COME. The advisory committee for the first meeting is shown in Figure 3C-1. The first advisory board meeting was held on August 3 and 4, 1972, in the Industrial and Engineering Technology Building. The Agenda for this meeting is shown in Figure 3C-2.

It should be noted that the staff of the Center for Metric Education had identified many of the major problems that they considered significant in developing instructional material. One of the first was the spelling of metre and litre. After much discussion the advisory committee decided that the metre/litre should be used in all instructional material developed at the Center.

In communicating with the advisory group, it was decided to adhere to the basic principles of good administration, which follow:

1. They are busy; hence, their time is valuable and limited, and they are impatient with long-winded communications.
2. They are interested in the subject.
3. They have been selected or are being communicated with because they have knowledge to give and contributions to make.
4. They feel a taxpayer's, a "civic" or public-minded", or a parent's interest in the community's educational programs. Employers have the added motivation of desiring an educational program, which will provide beginning employees with preparation which is relevant to the employer's needs.
5. They do not understand the jargon and technical terminology of professional technical educators and usually do not want to spend much time learning it. They feel that

the language must and can be simple.

6. They are "practical" persons rather than theoretical. They want to assess problems or situations, evaluate them, decide on a course of action, and get on with the solution.

7. They need quickly to find a common ground of concept and language to begin to communicate within a mutually understandable frame of reference if they are to become or remain challenged and effective contributors.

8. Almost all of them have a deep respect for what they consider the educator's perogatives, and they often hesitate to express their real ideas, suggestions, and criticisms for fear of encroaching on the educator's responsibilities or of seeming uninformed or presumptuous about educational programs or problems.

Immediately after the August meeting, a great deal of progress and attention was given to the recommendations of the committee, and progress was made on developing each of the basic kits.

On November 11, a communique was sent to the Center for Metric Education Advisory Board concerning the December 1, meeting. See Figure 3C-3. It was decided that at this meeting the afternoon discussion would be devoted to producing a one-hour video tape that could be used by schools and television broadcasters to explain some of the fundamentals of SI metric to various groups. The agenda for the advisory board meeting is shown as Figure 3C-4. The script for the Advisory Board Video Tape presentation is shown as Figure 3C-5.

In January, 1973, a communique was sent to all the advisory board members concerning the additional progress that had been made by the staff in developing various instructional materials.

At the December meeting it was decided that no future advisory board meetings would be needed until most of the material for the seven basic kits would be completed so that they could be reviewed for accuracy.

On August 15, 1973, another communique was addressed to the advisory board detailing progress to date and also setting up another advisory board meeting. This third meeting was held on Tuesday, October 23, at which time all of the material in each of the basic kits was reviewed by the group and evaluated so that any errors were corrected in preparation for the final printing of these materials.

During the last half of 1972 and most of 1973 the Advisory Board for the Center for Metric Education was the only formal group in the United States concerned with problems in metric education. However, with the establishment of the American National Metric Council, separate committees on various aspects of metric conversion were established. One of them was the committee on Education and Industrial Training. The Advisory Board for the Center provided the most useful and practical way for helping the staff develop valid, reliable and technically accurate material.

Figure 3C-1

ADVISORY BOARD

Center for Metric Education

Dr. Ralph B. Baldwin, President
Oliver Machinery Company
Grand Rapids, Michigan 49504
(616) 456-1591

Represented by: Mr. James Visser, Chief Engineer

Mr. John T. Benedict, Manager
Technical Information
Engineering and Research Office
Chrysler Corporation
P. O. Box 1118
Detroit, Michigan 48231
(313) 956-3942

Mr. John Brumm, Educational Director
International Association of Machinists
Aerospace Workers
1300 Connecticut Avenue
Washington, D.C. 20036
(202) 785-2525

Represented by: Mr. Lou Schmidt

Dr. William Dennis, Project Director
U.S. Office of Education
Department of Health, Education,
and Welfare
Washington, D.C. 20202
(202) 963-6269

Represented by: Miss Mary Marks

Mr. James E. Doebereiner
Supervising Engineer Product
The Timken Company
General Offices
Canton, Ohio 44706
(216) 453-4511

Mr. Lowell W. Foster, Director
Corporate Standardization Services
Honeywell, Incorporated
2701 Fourth Avenue, South
Minneapolis, Minnesota 55408
(612) 332-5222

Mr. Reiner Friedrich
Clark Equipment Company
525 North 24th Street
Battle Creek, Michigan 49016
(616) 964-5149

Mr. John D. Graham, Manager
Engineering Research
International Harvester Company
7 South 600 County Line Road
Hinsdale, Illinois 60521
(312) 325-1700

Mr. Lawrence M. Kushner, Director
National Bureau of Standards
U.S. Department of Commerce
Washington, D.C. 20234

Represented by: Mr. L. E. Barbrow, Consultant

Dr. Frances Parker, Chairman
Home Economics Department
Western Michigan University
Kalamazoo, Michigan 49001
(616) 383-1827

Mr. Norman R. Pugh, Assistant to the Director
Sears Laboratory
Department 817
Sears, Roebuck & Company
925 South Holman
Chicago, Illinois 60607
(312) 265-2500

Dr. Jack Simich, Education Director
Graphic Arts Technical Foundation
4615 Forbes Avenue
Pittsburgh, Pennsylvania 15213

Mr. Victor Schellschmidt, Manager
Engineering and Manufacturing
Caterpillar Tractor Company
East Peoria, Illinois 61611
(309) 675-4158

Mr. Ken Y. Taylor, President
Beloit Tool Corporation
P. O. Box 38
South Beloit, Illinois 61080
(815) 389-3461

Mr. Roy P. Trowbridge, Director
GM Engineering Standards
General Motors Corporation
General Motors Technical Center
Warren, Michigan 48090
(313) 575-1314

Represented by: Professor William Lichty
General Motors Institute

Figure 3C-2

A G E N D A

Advisory Board, Center for Metric Education

Begin -- 1:00 p.m. Thursday, August 3, 1972
End -- 11:30 a.m. Friday, August 4, 1972

Project Title: Metrication of Technical Career Education
Project No.: V257006
Grant No.: OEG-0-72-1868

Welcome -- Dr. Russell Seibert
Vice President, Academic Affairs
WMU

Remarks -- Dr. George Kohrman, Dean
College of Applied Sciences
WMU

Introduction of Participants & Guests

Overview of Three-Year Project

Project Purpose

To develop instructional material in metric measurement and standards and to hold inservice seminars for teacher educators of career education in colleges and universities throughout the United States. These teacher educators, in turn, would introduce the metric system to teachers who will work primarily from the 8th through the 14th year including those students who plan to make a career of an occupation in industry and business at the technician's level and below. The major areas of emphasis will be in industrial education, drafting, machine shop, building construction, graphic arts and in home economics and consumer education.

Progress to Date

1. Library being organized.
2. Metric tools for machine shop, drafting and woodworking purchased and kits being developed.
3. Basic package for students.
4. Basic package for teachers.

Thursday, August 3, 1972

I. Project Instructional Materials
   A. Basic Kit for students
   B. Transparency masters for career teachers
   C. Transparency masters for occupational areas:
      1. Drafting
      2. Graphic Arts
      3. Home Economics and Consumer Education
      4. Metal and Machine Shop
      5. Wood and Building Construction
   D. Tool kits for:
      1. Drafting
      2. Home Economics and Consumer Education
      3. Machine Shop
      4. Woods
   E. Other Technical Areas
      1. Automechanics
      2. Power
      3. Electricity/Electronics
   F. Filmstrips and tapes
   G. Basic movie
   H. Charts and posters
   I. Elementary K-6
   J. Industrial technology (Advanced metrics--Newton, Joule, Watt, etc., and their applications)
   K. Occupational analysis of clusters to determine need for metric education
   L. 3-D models

II. Level of Instruction in SI Metric
   A. Junior high school students -- general industrial arts and home economics
   B. Senior high school students -- pre-vocational programs in drafting, machine shop, building construction, graphic arts, home economics, etc.
   C. Thirteenth and 14th years -- vocational student centers, skill centers, etc., planning to enter industry and business at the job entry level
   D. Community/junior college students who will become technicians in industry

III. Teaching Problems
   A. What units to teach?
   B. Spelling - metre?
   C. How much conversion?
   D. How to teach the "feel" for metrics?
   E. Conversion calculator
   F. Any industrial training programs? Can we see them?
   G. How much to teach the worker - just enough to do his job?

IV. Dinner announcements - dinner at Greco's, Maple Hill Mall at 7:00 p.m.; let us know if you need transportation.

V. Adjourn

Friday, August 4, 1972

I. Meeting Devoted to Standards
   A. Whose standards to use? ANSI or SI
   B. Use of first angle projection in drafting
   C. Method of dimensioning
      1. Dual
      2. Metric only
      3. Chart on drawing
   D. ISO standards for threads
   E. Adapting an educational program to an evolving program of standards; i.e., what should drafting and machine shop students know about ISO inch, ISO metric, and IFI metric thread standards?
   F. Keeping educational programs current and up-to-date with new standards as they are developed.
   G. Other

II. Role of Advisory Committee
   A. Number of meetings
   B. Continuing contacts with members
   C. Publicity
   D. Inform center of forthcoming meetings and literature

III. Adjourn

Figure 3C-3

Date: 11/6/72

TO: CME Advisory Board

FROM: John Feirer & John Lindbeck

During our August conference we discussed the possibility of a second meeting in late November. Your response to our recent survey indicated that December 1 appears to be a good day for it. We feel that a 9:30 a.m. starting time should give us sufficient time to give you a progress report, have you examine some of our preliminary educational materials, and discuss issues of mutual concern. We shall adjourn around 4:00; these convening and closing times should permit you to make convenient travel connections in and out of Kalamazoo on the day of the conference.

An agenda follows. Please note that we are scheduled to video tape a 30-40 minute segment of our proceedings. We intend to use this as an orientation tape for the regional seminars to be held during the second and third years of the project. It may also be used by local groups for orientational purposes, or, perhaps, for local television programs. These uses will be discussed at our meeting.

Please note that a suggested script format accompanies this letter. We are, in effect, "feeding" each of you a question for which you will be given 2-3 minutes for response. Brevity is, obviously, important; this is not intended as an exhaustive appraisal of issues, but rather a brief statement of factors related to the matter of metrication. As you prepare your answer, bear this in mind.

We will be reserving a block of rooms at the Holiday Inn, Crosstown, for Thursday evening, November 30. Please confirm if you will be here then for the night. Also, if you need a ride from the airport to the Holiday Inn, please call either John Feirer at 345-4947 or John Lindbeck at 349-2862. Otherwise someone will pick you up at 8:45 a.m. at the Holiday Inn lobby on the morning of December 1 to bring you to the conference. If you have any questions regarding any of the arrangements, please contact us.

jat

Figure 3C-4

A G E N D A

CME Advisory Board Meeting
Friday, December 1, 1972
Room 2053
Industrial & Engineering Technology Building
Western Michigan University

9:00- 9:30	Coffee and greetings
9:30-10:00	Introduction of new members and guests & Progress report of CME activities - John Feirer
10:00-12:00	Examination and discussion of metrication issues: - Canadian metrication activities - Use of comma and period - Progress in standards - Timetable of legislation - New developments in industry - Other
12:00- 1:00	Luncheon
1:00- 2:30	Video taping of board session, Studio C, Dunbar Hall
2:30- 4:00	Continuation of metric issue discussion
4:00	Adjourn

Figure 3C-5

Script for Advisory Board Video Tape Presentation

This is the second meeting of the Center for Metric Education Advisory Board. The Center is located at Western Michigan University. I am John Feirer, Director of the Center; Dr. John Lindbeck is Co-Director; Miss Judy Triemstra is the Executive Secretary and Librarian.

There has been much national interest in the conversion to metric measurement. We thought it would be valuable for our viewers to get some first-hand information from national and international leaders in metric conversion who are members of our Advisory Board. We are going to call on individual members of the Board to answer for us some of the most frequently asked questions concerning the United States' movement toward the metric system.

First of all, Mr. Kushner, could you explain for us briefly what the SI metric system is, and what its relationship is to our customary system.

Mr. Taylor, you have been very active in the "Go Metric" activities. Could you explain briefly why you think the Unites States industry should go metric now.

Mr. Schellschmidt, your company has recently converted all measurements to metric. Could you explain to us what the difference is between converting measurements to metrics and using international standards for parts.

Mr. Trowbridge, you are President of the American National Standards Institute. What do you see as the relationship between your organization and the ISO organization in Switzerland?

Mr. Doebereiner, you have heard Mr. Trowbridge tell about the relationship to ISO. Some time ago your company went to all metric measurements and standards for bearings but are having a problem with ISO engineering standards. Could you briefly explain this problem.

Mr. Benedict, the automobile industry is one of the largest industries in the country. What would going metric mean to this industry?

Mr. Simich, we recently heard that the toothpaste industry had already converted to several modules of

metric size toothpaste containers--the smallest being 25 millilitres. What does this mean to the graphic arts industry, particularly the packaging industry?

Mrs. Swain, you represent one of the largest manufacturers of food products. How do you think converting to the metric system will affect the dual measurements on boxes (such as ounces and grams); and will packaged materials be made to fit modules of metric measure (such as 100 grams, 200 grams, etc.)?

Mr. Foster, the Honeywell Company recently, I understand, developed a corporate policy to go metric. What will this actually mean to a large company, and what do you think it will cost the company to make this change over a ten-year period?

Mr. Irvin, the development in the woodworking field particularly building construction has not as yet been affected in the United States by metric conversion; however, what do you see in the immediate future for changing the school wood labs to utilize metric measurement?

Dr. Parker, in homemaking and consumer education, how successful do you think converting to the metric system will be for the housewife? Will it change her cooking habits, for example?

Mr. Friedrich, you received your schooling and grew up in Germany--a country on the metric system for many years. What do you see as major problems in converting the United States to the metric system of measurement?

Mr. Bell heads the Task Force for the Provice of Ontario in Canada, and they already have a metrication board and are moving along at a pace ahead of the United States. How do you think the two countries should cooperate particularly in the relationship to the somewhat small but important details of uniform spelling, uniform use of the period to indicate decimal measure, etc.?

Mr. Graham, you have been an expert in the metric conversion field for many years. Could you explain briefly why the metric SI system of measurement is to be preferred over the old customary system or old metric system?

Mr. Schmidt, as a leading figure in the International Association of Machinists and Aerospace Workers, can you give us your opinion on the receptivity of the Unions to the matter of metrication?

Dr. Teske, this project is being sponsored by the USOE largely for the industrial-vocational and consumer education programs from the 8th through the 12th year. What do you think should be done in grades K through 7 and in the post-technical and engineering programs?

Dr. Lindbeck, explain briefly what the Center's plans are for 1972 and 1973.

Section 3

Part D

DEVELOPING THE INSTRUCTIONAL MATERIALS

The first problem that the Center faced was to determine the kind of instructional materials that would be developed as part of this project. The following criteria were established:

1. The material had to be visual in nature.
2. Material had to be easily reproduced.
3. The material had to be usable in shop and lecture classes.
4. Material was designed for teacher education purposes.

Analyses of the advantages and disadvantages of various audio-visual materials made it abundantly clear that the most practical approach to use was to develop transparency masters that could be easily reprinted when necessary and also made into transparencies. The use of the overhead projector along with transparencies is the most common type of audio-visual material used in teacher education programs.

Therefore, it was decided that each kit should be based on a series of transparency masters plus suitable notes that could be either read by the teacher or used as background in explaining each of the transparencies. The exact number and kind of transparency masters were based on an analysis of the teaching materials to determine exactly what aspects of the program would be most greatly influenced by metric conversion.

In contrast to math and science where the primary problem in metric conversion is to teach students the SI metric measuring system, the problem in most of the career cluster areas, particularly those related to industry and technology, is that learning the metric measuring system alone is only about twenty-five percent of the total educational problem. The two other main categories of instructional time is that dealing with the application of metric measurement, tools, machines, drawings and devices and the understanding and application of international standards. Figure 3D-1.

A word of explanation on the last two will provide some insight to the complex problem of metric conversion in these areas. For example, in teaching the metric system of measurement, the base unit of length, namely the metre, will be the principle or major area of concern for much of the instruction. However, learning the metric measuring system as it applies to areas such as drafting, machine shop, etc., is much more complicated. Even though a student may know what a metre and millimetre are, this will not suffice in the drafting room, for example. Here the student must be able to apply this learning to the metric scales that are used in which enlargements and reduction scales are in units of ten, namely 1:1, 1:2, 1:5, 1:10, 1:100 and so forth. Learning to read a metric architecture scale that has a reduction of 1:10 is quite different than reading a standard rule.

The same applies in areas of other measuring tools. For example, there are four basic different types of metric micrometers, each of which requires different learning techniques. This means that the cognative and psychomotor learning must be carefully identified. Every tool, machine or drawing that has any kind of measurement on it will require a new application problem.

From a teacher-learner point of view the most complicated aspect of metric conversion is that dealing with the international standards that will be used. These international standards developed by the International Organization for Standardization will probably be adopted by most nations now going metric. This has been true in Great Britain where all of their new standards for engineering materials are based on ISO standards. The American National Standards Institute is the offical representative in the United States to the ISO and is working with other national groups to develop compatible standards for approximately one thousand different engineering and industrial materials that will be used. All new engineering materials in the years ahead will be based on metrics.

Transparency masters, therefore, concentrated on the application of SI metric measurement to tools, machines and drawings and also to standards. The major problem was that there were very few engineering standards in metric available in 1972, and only a few have been developed since that time.

For example, the OMFS metric thread series that has recently been established for American industry was originally published in 1972. When the standards were first published, five of the twenty-five basic sizes of metric

threads were not compatible with the ISO thread system. Therefore, when the instructional material was developed by the Center, these early standards were used. Since that time there have been changes so that now only one size, namely 6.3 mm, is not compatible with ISO standards.

The second major problem faced by the Center was the development of the actual tool kits. Based on the curriculum analyses the Center identified those new hand tools that would need to be replaced. These were primarily the measure-sensitive tools such as rules, micrometers, vernier calipers, etc., that are used in each of the technical areas. A very careful selection was made of the basic tools that were needed and these were incorporated in the standardized kit that was designed and built in the lab. Photographs and drawings of the kit itself are a part of the total package as well as a list of the metric tools and their costs with alternate sources.

It should be noted that in 1972 it was very difficult to secure metric measuring tools, particularly from U.S. manufacturers. Therefore, a number of the tools included in the orginal kits were of foreign origin. However, alternate sources showing those United States' companies who produce tools were included in each of the lists.

A complete description of the instructional material produced appears as Figure 3D-2. Copies of the material produced are available as Volume II of this study.

Figure 3D-1

ANALYSIS OF INSTRUCTIONAL TIME ALLOTMENTS

METRIC MEASUREMENT AND INTERNATIONAL STANDARDS

INDUSTRIAL AND TECHNICAL AREAS

		INSTRUCTIONAL TIME
Metric Measurement SI	Base Units Derived Units	25%
Application of Metric Measurement to tools and machines and drawings	Tools: rule, scale, micrometer, vernier, dial indicator, etc. Machines: dual reading dials Printings and Drawings	25%
International Standards - ISO	Screw threads Bearings Gears Papers Splines Plus about 10 000 other standards	50%

Figure 3D-2

INSTRUCTIONAL MATERIALS
PRODUCED BY THE CENTER FOR METRIC EDUCATION

The following seven packets of instructional materials were prepared for experimental use. All seven of these learning kits are packaged individually and the seven are then packaged in one large container that measures approximately 300 mm by 400 mm and weighs over 700 grams. However, only 300 copies of this Phase I series were printed. Each college or university having an industrial teacher education program in the United States will receive one of these packets after members of the department have participated in an inservice seminar program sometime during 1973-1974.

1. Course of Study and Tool Kits--This packet includes a 10-page course outline for metric measurement and ISO standards including a selected metric bibliography that can be used for a course of any length. It also includes drawings in metric for the four material carrying cases, photographs and complete tool lists for each of the kits including one for drafting, general metals, machine shop and woodworking. The tool lists include specific descriptions of the tools--micrometers, rules, etc.--needed and various sources for purchasing this equipment. The total cost for the actual tools included in these kits amounts to approximately $1,297.00.

2. Going Metric for Students--This packet is designed for student use and includes the following: a 300 mm rule, a metric/inch converter, four tables of materials including ALL YOU WILL NEED TO KNOW ABOUT METRIC, APPROXIMATE RELATIONSHIPS BETWEEN SI METRIC AND CUSTOMARY (ENGLISH) (WITHIN 10%), and COMPARING THE COMMONEST MEASUREMENT UNITS, WITH APPROXIMATE CONVERSIONS. This is followed by a full color 4-page insert from the National Bureau of Standards titled THE MODERNIZED METRIC SYSTEM. A 4-page programmed unit based on this chart follows. In addition, the kit contains 14 pages of learning activities dealing with metrics including estimating, measuring length, area, volume, temperature, mass, etc. A student using this self-learning kit could have a basic understanding of metric measurement.

3. Going Metric for Career Education--This is a

basic packet that can be used in all career areas and covers all fundamentals of SI metrics. It includes 5 pages of notes and 45 transparency masters. Disney-like characters were used for each of the 7 base units.

4. Going Metric in Drafting--This is the largest packet in the series and includes 12 pages with notes and 55 transparency masters covering every aspect of metric measurement and ISO standards needed by drafting instructors.

5. Going Metric in Metalworking--This is the second largest packet and includes 8 pages of notes and approximately 50 transparency masters covering measuring tools, ISO threads, machinery conversion, etc., to convert any general metal or machine shop to metric.

6. Going Metric in Graphic Arts--This includes 2 pages of notes and 15 transparency masters covering paper sizes and weights and metric measurement used by printers and graphic arts specialists.

7. Going Metric in Woodworking and Building Construction--Included in this packet are 5 pages of notes and 11 transparency masters that can be used by anyone teaching cabinetmaking, building construction and related trade areas.

Section 3

Part E

SEMINARS

SURVEY SEMINARS

When the matter of dissemination of the instructional packets was discussed with the Advisory Board, it was first intended that perhaps one seminar would be held on the campus of Western Michigan University to which one teacher educator from each institution in the United States would come for the indepth seminar. However, most of the Advisory Board felt that this method would probably not be the most effective way of obtaining good dissemination.

Under the original plan the Department Head would probably be the only representative from each of the institutions involved. Normally he was not as interested in the technical aspects of metric conversion as the individual teacher educators in the various areas. The Board recommended that far better coverage would be obtained and more teacher educators involved by offering the program at a series of regional seminars and at national conventions.

The decision was made to offer a minimum of nine workshops at regional and national meetings. By this method it was possible to secure better coverage and also to make it possible for teacher educators in many of the technical areas included in this study such as those in drafting, building construction, graphic arts, general metals and machine shop to be in attendance and have an opportunity to gain insight into what metric conversion will mean in their technical areas.

To implement this plan it was decided to have at least one seminar in each of the regions of the United States and two seminars at the national American Industrial Arts Association Convention and the national American Vocational Association Convention. In some regions of the country there is a well-structured organization of teacher educators. This is particularly

true in the mountain states, the southeast and by far the largest group at the Mississippi Valley Industrial Arts Conference, which includes educators from all of the central region of the United States including an area enclosed by the States of Ohio, Alabama, Texas and North Dakota.

The first three conferences were offered for teacher educators only with a total of approximately two hundred sixty in attendance. The other six conferences were offered for both teachers and teacher educators. However, to make sure that teacher educators were in attendance, the Center had a letter survey sent to each teacher education institution in the area to be served with a postcard response card to make sure that there would be representatives from each of the teacher education institutions at each of these seminars. Examples of the correspondence are shown as Figure 3E-1.

Also to evaluate the effectiveness of the conference, a form was passed out to each of the participants of the seminar to secure their response to the presentation. This form is shown as Figure 3E-2a. Typical comments on the seminars appear as Figure 3E-2b.

A list of the conferences showing dates, locations, groups served, presentor and attendance is shown in Figure 3E-3.

As a result of this procedure, every teacher education institution in the United States had at least four opportunities to attend the seminar; namely, one in their region, and one at three national conventions.

One of the distinct advantages of this method of dissemination was that several teacher education institutions were represented at two or more of these seminars with different teacher educators in attendance. As a result, often times three or four teacher educators from a specific institution attended the seminar.

After the seminar was presented an institutional representative was asked to sign the receipt card indicating that their institution had received a complete packet of the materials. A complete list of those receiving packets with the name of the recipient of the packet is shown in Appendix A.

The general reaction to these seminars was excellent. Most of the attendants were enthusiastic about the opportunity for metric conversion in industrial

education. Generally the only criticism of the seminars was the fact that there was not enough time to go into great depth in each of the technical areas to discuss problems.

As a result of these seminars, many of the institutions have accepted the challenge to disseminate the material for their geographic area. A further evaluation concerning the use of these instructional packets is covered in the next section.

In spite of the fact that every industrial teacher education center in the United States was invited by personal letter to four of the seminars, approximately twenty percent of the colleges and universities did not send a representative to one of these workshops. In a last attempt to interest those schools in metric conversion a letter was sent to each department offering to send a kit of materials providing the department head would write a letter requesting it. Figure 3E-4. As a result of this final letter, about ten percent of the institutions not attending a seminar requested the package of materials.

INDEPTH SEMINAR

As part of a no-cost extension of this project, a two-week seminar for vocational-technical teachers and teacher educators was held at Colorado State University, Fort Collins, Colorado, during the last two weeks of June, 1975. This two-week seminar provided an opportunity for the indepth evaluation of all the instructional materials that have been provided to teacher education institutions. All facets of metric conversion as it applies to vocational and technical education were covered.

A total of forty contact hours of instructional time plus individual outside assignments was the required time frame. A complete course outline for the metric seminar is shown in Figure 3E-5.

To determine the effectiveness of this seminar a basic and technical test was developed covering the fundamentals of SI metric and the application of SI metric to vocational and technical areas. Figures 3E-6a and 3E-6b. The same test was offered at the beginning of the seminar and at the end of the seminar to determine what changes were made in the scores of the

participants. Significant improvement was shown both in the basic and technical test scores. On the basic test there was an average of twenty errors per student when the test was offered at the beginning of the seminar. This was reduced to an average of seven errors per student at the end of the workshop. For the technical test there was an average of twenty errors per student at the beginning of the session and seven and a half errors per student at the end of the seminar. These results show significant improvements in the basic understanding of SI metrics and its applications to the industrial-vocational areas. Figure 3E-7.

Among the other assignments each seminar participant was required to critique two of the eight kits including the seven kits entitled GOING METRIC IN INDUSTRIAL EDUCATION, and GOING METRIC IN HOME ECONOMICS. Evaluations of the metric kits are shown in Appendix B.

In addition, each student was required to critique the seminar to determine how future seminars could be improved, and how the operation of the seminar could be streamlined. These evaluations are shown in Appendix C.

Among the major suggestions from the participants were:

1. More time was needed to be devoted to the derived units. These are commonly called the technical units. The major technical units that are of significant interest to vocational-technical teachers are the newton, the pascal, the joule, the watt, the hertz, the newton-metre and the unit for density, namely the kilogram or cubic metre.

These derived units require an entirely different understanding and "feel" on the part of any individual involved in technical work. For example, the pascal, which is the unit of pressure, will replace the customary measurements in pounds per square inch (psi). The relationship between the kilopascal (a thousand pascals) and the psi is that the kilopascal is approximately seven times as great. For example, the tire pressure that was given as thirty psi in the customary system will have a kilopascal reading of two hundred ten kPa. All technicians and engineers must develop this new "feel" for the metric technical units. Therefore, these must not only be taught to the students but enough

practice must be encountered in using the unit in typical situations to develop this "feel".

2. All the seminar participants indicated that what was needed was additional, supplementary material including software such as textbooks, workbooks, films and other sources of information and also sources of equipment and supplies in metrics.

Figure 3E-1

CENTER FOR METRIC EDUCATION
WESTERN MICHIGAN UNIVERSITY
KALAMAZOO, MICHIGAN 49008

November 12, 1973

Dear Sir:

Conversion to the metric system and use of international standards will be the most important problem facing industrial education in the years ahead. To help prepare you for the problems involved, a one-day seminar will be offered at Arizona State University in Tempe, Arizona, on February 8, 1974. At this time you will receive a complete packet of instructional material that will aid you in converting your program to SI metrics.

We hope you can be in attendance, and we will look forward to seeing you at this meeting.

Sincerely,

John L. Feirer, Director
Center for Metric Education

jr

CENTER FOR METRIC EDUCATION

WESTERN MICHIGAN UNIVERSITY
KALAMAZOO, MICHIGAN 49008

March 15, 1974

Dear Fellow Educator:

Do you or one or more members of your staff plan to attend the American Industrial Arts Convention in Seattle, Washington, in April? If so, we hope that you will plan to be at the seminar on metric conversion that we will be offering.

To date we have offered five regional seminars including ones in Brighton, Utah; Atlanta, Georgia; Chicago, Illinois; Tempe, Arizona; and Bakersfield, California. For one or more reasons your institution was not included in any of these groups. Therefore, we hope that someone will be in attendance at the Seattle conference on April 18, 1974.

As you know, we have a federally funded project that has three objectives:

1. To develop a series of seven instructional packets on metric conversion.

2. To offer seminars to industrial teacher educators on a regional basis.

3. To provide a representative of each institution who has attended a seminar a complete set of our materials.

If for some reason you cannot possibly attend this meeting, the Center will probably offer the same kind of program at the AVA Convention in New Orleans in December.

Please complete the enclosed post card and return it to us before April 1, 1974.

Sincerely,

John L. Feirer, Director
Center for Metric Education

jr

Enclosures

Sample of post card enclosure:

CENTER FOR METRIC EDUCATION
WESTERN MICHIGAN UNIVERSITY

_____ Yes, I am planning to attend the metric seminar during the AIAA Convention in Seattle, Washington, on April 18, 1974, from 10:45 a.m. until 12:00 noon.

_____ No, I do not plan to attend the metric seminar.

_____
(Name of Institution)

Figure 3E-2a

CENTER FOR METRIC EDUCATION - WESTERN MICHIGAN UNIVERSITY

METRIC SEMINAR EVALUATION FORM

Program Title: "Going Metric in Industrial Education"
Date & Place: _____

A. Additions or corrections to the kits.
   1. Student Kit
   2. Going Metric for Career Education
   3. Woodworking
   4. Metalworking
   5. Drafting
   6. Graphic Arts

B. Program Content:	Excellent	Good	Fair	Poor
1. Was the material presented of practical value to you?	_____	____	____	____
2. Was the material presented in an understandable manner?	_____	____	____	____
3. Were the questions answered?	_____	____	____	____
4. Was there sufficient amount of time to cover the subject?	_____	____	____	____

C. What changes would you recommend if this program were rescheduled?

_____

_____

_____

D. Please use the back of this sheet to list any additional instructional material you would like to see the Center develop and any additional comments you have about this program.

_____
Signature (Optional)

Figure 3E-2b

TYPICAL COMMENTS ON REGIONAL SEMINARS

"More sessions."

"Packets should be sent to State Department of Education."

"More information handed out to the audience as to when materials may be secured in their area."

"Feel that it was well done."

"Use metric examples during speech."

"For the time allowed, I think Dr. John Feirer presented the material as well as anyone could have--making us aware of the many problems involved."

"We will definitely use your materials."

"I felt more time should have been available."

"This presentation is very good--it would be nice to have some more time with the material in an initial presentation."

"Much more time and a P.A. for speaker."

"Get a better room which allows for better seating and viewing (not your fault in this case). Some parts of presentation were rushed. I would have liked to have gone into more detail. I wish you could come to our college to put this presentation on for our staff. Any possibility?"

"Two programs of two hours each."

"Smaller group presentation with more questioning would be helpful."

"A critique of sources of materials with respect to which companies are marketing good materials and which are marketing unacceptable materials."

"No change--keep the enthusiasm!"

"Excellent"

"Excellent presentation."

"More time scheduled for more details."

"Did an excellent job in presenting the metric system--a very interesting and worthwhile program."

"Program could be broken down into two or three sessions with more time to view some slides. This was a very excellent presentation--one of the best at our conference."

Figure 3E-3

DISSEMINATION ACTIVITIES

Date	Location	Group Served	Presentor	Attendance
October 1973	Salt Lake City Utah	Mountain States Industrial Arts Teacher Educators and Industrial Arts Supervisors	Lindbeck	50
October 1973	Atlanta Georgia	Southeastern Industrial Arts Conference	Lindbeck	60
November 1973	Chicago Illinois	Mississippi Valley Industrial Education Conference	Feirer	150
February 1974	Tempe Arizona	Arizona State Industrial Education Conference	Lindbeck	25
March 1974	Bakersfield California	California Industrial Education Association	Feirer	175
April 1974	Seattle Washington	American Industrial Arts Association International Conference	Feirer & Lindbeck	150
November 1974	Oswego New York	Industrial Arts Conference	Feirer	150
Nomveber 1974	South Egremont Massachusetts	New England Industrial Arts Teachers Association	Feirer	375
December 1974	New Orleans Louisiana	American Vocational Association Convention	Feirer	250

Figure 3E-4

CENTER FOR METRIC EDUCATION
WESTERN MICHIGAN UNIVERSITY
KALAMAZOO, MICHIGAN 49008

May 9, 1975

Dear Industrial Teacher Educator:

As part of a federally funded project entitled, Metrication of Technical Career Education, we had three main objectives.

1. Prepare kits of instructional materials in five technical areas plus a kit for career teachers and students.

2. Present seminars for industrial teacher educators at regional and national conventions.

3. After a representative of a teacher education program has attended one of these seminars, we give this institution a complete set of our instructional material.

Your institution has been invited to three national seminars--one at the AIAA in Seattle, Washington; one at the AVA in New Orleans; and one at the AIAA in Cincinnati; plus one regional meeting in your geographic area. In each case we sent you a personal letter with the date of the program and a return card asking if you or a member of your department would be in attendance. To date, one of the following has occurred with your invitation.

1. You indicated that you would be in attendance but no one appeared. Even though we had a heavy attendance at the AIAA in Cincinnati, only two of the twelve institutions indicating they would be in attendance had a representative there.

2. You indicated that for some reason you could not attend any of the four seminars.

3. We received no response.

Within the next few months we are planning a follow-up study to determine how industrial teacher education departments are utilizing the material produced. Incidentally, about eightly percent of all the industrial teacher education programs in the United States have our materials. Almost all of the large departments have received their packets.

We would be willing to provide your institution with these materials providing you will write to us indicating that you will participate in our follow-up study. If you are interested in receiving this material, would you please write to us indicating:

1. that you would like your packet of materials, and

2. that you will participate in a follow-up study that will be sent to you sometime this fall.

Sincerely,

John L. Feirer, Director
Center for Metric Education

jr

Figure 3E-5

METRIC SEMINAR - COURSE OUTLINE

DATE	COURSE OUTLINE	AUDIO-VISUALS	ACTIVITIES & ASSIGNMENTS	OTHER ASSIGNMENTS
Monday June 16	1- History of Measurement 2- Basic SI Metrics 3- Technical SI Metrics	FS- Introduction to SI	Pre-test - Metric You Self Study Book A (Introduction to the Modernized Metric System)	No Special Dates: 1. Critique of: A. 7 Going Metric kits
Tuesday June 17	4- Length 5- Area 6- Volume and Capacity	TM- Length TM- Area TM- Volume and Capacity	Self Study Book 1 (Length) Self Study Book 2 (Area) Self Study Book 3 (Vol. and Cap.)	B. Going Metric in Home Economics
Wednesday June 18	7- Mass and Weight 8- Temperature 9- Other Base Units and Supplementary Units 10- Derived Units	TM- Mass and Weight TM- Temperature TM- Derived Units FS- Derived Units	Self Study Book 4 (Mass and Temperature)	
Thursday June 19	11- Rules When Using SI Units 12- Conversion Methods and Techniques 13- Historical Persons in SI Metric	TM- Rules Pictures of Scientists		
Friday June 20	14- Precision Metric Rules 15- Metric Micrometers 16- Vernier Calipers, Height-Depth Gage 17- Other Precision Measuring Tools	FS- Reading a Metric Rule TM- Micrometer FS- Micrometer FS- Vernier Caliper	Self Study Book B (Rules) Self Study Book D (Micrometers) Self Study Book C (Vernier Caliper) Self Study Book E (Other Precision Measuring Instruments)	
Monday June 23	18- National and International Standards 19- Paper Standards 20- Thread Standards 21- Other Engineering Standards	TM- Threads FS- Threads		

FS - filmstrip
TM - transparency

METRIC SEMINAR - COURSE OUTLINE

DATE	COURSE OUTLINE	AUDIO-VISUALS	ACTIVITIES & ASSIGNMENTS	OTHER ASSIGNMENTS
Tuesday June 24	22- Metrics in the Design Stage 23- Drafting Equipment and Supplies 24- Drafting Methods and Standards 25- Beginning Drafting Practices	FS- Geometric Dimensioning and Tolerancing TM- Going Metric in Drafting	Self Study Book F (Drafting Scales) Self Study Book G (Drawings)	2. Design project in metric modules 3. Convert customary drawing to metric 4. Make drawing with dual dimensioning 5. Make drawing with metric chart method
Wednesday June 25	26- Conversion of Machine Tools 27- Metric Machining 28- Cutting Metric Threads 29- Threaded Fasteners 30- Wrenches 31- Other Metalworking Areas	TM- Going Metric in Metalwork		6. Develop a metric learning unit for area of interest: A. Curriculum Analysis B. Learning Units C. Metric Competency D. Performance Objectives E. Activities F. Evaluation
Thursday June 26	32- General Woodworking Including Forestry and Furniture Construction 33- Building Construction 34- Graphic Arts and Printing 35- Automechanics 36- Electricity & Electronics	TM- Going Metric in Woodworking and Building Construction TM- Going Metric in Graphic Arts		
Friday June 27	37- Office Practice 38- Marketing and Distribution 39- Foods and Nutrition 40- Clothing and Textiles 41- Agriculture 42- Health 43- Home and Family Living	FS- Planning a Metric Education Program TM- Home Economics	Post Test	7. Critique of Seminar

FS - filmstrip
TM - transparency

Figure 3E-6a

PRE-TEST--BASIC

1. The basic unit of length is the:
   A. millimetre
   B. metre
   C. centimetre
   D. decimetre

   _____

2. The correct symbol for the base unit of length is:
   A. m.
   B. m
   C. M
   D. M.

   _____

3. The correct symbol for the millimetre is:
   A. MM
   B. MM.
   C. mm
   D. mm.

   _____

4. If the distance to the store is 4 000 metres, than this distance in kilometres would be:
   A. 0.04
   B. 4
   C. 40
   D. 400

   _____

5. What is the distance in kilometres if the earth is 12 742 000 metres in diameter?
   A. 127 420
   B. 12.742
   C. 1 274.2
   D. 1 274 200

   _____

6. The prefix centi means:
   A. one hundredth
   B. one thousandth
   C. one hundred
   D. one thousand

   _____

7. The prefix milli means:
   A. one billionth
   B. one thousandth
   C. billion
   D. million

   _____

8. The prefix micro means:
   A. billionth
   B. millionth
   C. billion
   D. million

_____

9. The 12 inch rule will be replaced by one with a length of:
   A. 100 millimetres
   B. 300 millimetres
   C. 200 millimetres
   D. 400 millimetres

_____

10. The thickness of a dime is:
   A. 0.5 millimetres
   B. 1 millimetre
   C. 0.1 millimetre
   D. 5 millimetres

_____

11. The base unit of mass or weight is the:
   A. gram
   B. kilogram
   C. metric ton
   D. milligram

_____

12. The symbol for the base unit of mass (weight) is:
   A. g
   B. kg
   C. KG
   D. G

_____

13. Five grams is about the weight of:
   A. an apple
   B. a nickel
   C. a pineapple
   D. not sure

_____

14. A newborn baby weighs about:
   A. 3 kilograms
   B. 30 kilograms
   C. 300 kilograms
   D. not sure

_____

15. The everyday unit of temperature in the metric system is:
   A. kelvin
   B. degrees Celsius
   C. centigrade
   D. Celsius

_____

16. Water freezes and boils at:
    A. 32 °C and 212 °C
    B. 100 °C and 200 °C
    C. 0 °C and 100 °C
    D. not sure _____

17. Normal body temperature is:
    A. 28.5 °C
    B. 37 °C
    C. 42.7 °C
    D. not sure _____

18. A professional football player weighs about:
    A. 45 kilograms
    B. 110 kilograms
    C. 180 kilograms
    D. not sure _____

19. A litre is a derived unit equal to:
    A. cm^3
    B. dm^3
    C. mm^3
    D. m^3 _____

20. A litre of water weighs:
    A. 100 grams
    B. 10 grams
    C. 1 kilogram
    D. not sure _____

21. The metric ton is a derived unit that is equal to:
    A. kkg
    B. Mg
    C. 10 kg
    D. 100 kg _____

22. The following is a true statement:
    A. The yard is longer than a metre
    B. The centimetre is larger than an inch
    C. A kilometre is smaller than a mile
    D. 300 millimetres is longer than a foot _____

23. The following is a true statement:
    A. The gram is heavier than a U.S. ounce
    B. The pound is heavier than 1 kilogram
    C. A gram is lighter than an ounce
    D. A metric ton is equal to a U.S. long ton _____

24. The following is a correct statement:
    A. The litre is smaller than a quart
    B. The quart is larger than a litre
    C. There are about 3 3/4 litres in a gallon
    D. A U.S. pint is almost equal to a litre _____

25. One U.S. pound is the equivalent of:
    A. 385 grams
    B. 454 grams
    C. 525 grams
    D. 648 grams _____

26. In comparison, 1.82 metres would equal approximately how many yards?
    A. 1
    B. 2
    C. 3
    D. 4 _____

27. A square metre is:
    A. 20 percent larger than a square yard
    B. 20 percent smaller than a square yard
    C. the same as a square yard
    D. 50 percent larger than a square yard _____

28. A quart of liquid contains about:
    A. 1.95 litres
    B. 0.95 litres
    C. 2.95 litres
    D. 3.95 litres _____

29. A 16 ounce hammer weighs about:
    A. 45 kg
    B. 45 g
    C. 454 g
    D. 4 500 g _____

30. The volume of water that weighs one gram is:
    A. 1 litre
    B. 1 millilitre
    C. 1 decilitre
    D. 1 centilitre _____

31. A millilitre is equal to:
    A. 1 cubic decimetre
    B. 1 cubic centimetre
    C. 1 cubic millimetre
    D. 1 cubic metre _____

32. A hectare is a derived unit equal to:
    A. 1 km^2
    B. 1 hm^2
    C. 1 dam^2
    D. 1 dm^2

_____

33. One millimetre is approximately:
    A. 1/25 of an inch
    B. 1/20 of an inch
    C. 1/10 of an inch
    D. 1/15 of an inch

_____

34. Five miles is equal to approximately:
    A. 7 kilometres
    B. 10 kilometres
    C. 8 kilometres
    D. 6 kilometres

_____

35. 10^{-3} is the exponent for the prefix:
    A. 1
    B. 1/10
    C. 1/1000
    D. 1/100

_____

36. An inch equals about how many millimetres?
    A. 20
    B. 25
    C. 30
    D. 15

_____

37. The correct way of expressing numerical values of less than one is:
    A. 1/4
    B. .50
    C. .75
    D. 0.50

_____

38. The following is the correct form for the number and symbol for 3 kilometres:
    A. 3km
    B. 3 km
    C. 3 km.
    D. 3-km

_____

39. Ten centimetres is equal to a:
    A. millimetre
    B. metre
    C. decimetre
    D. kilometre

_____

40. Ten millimetres are equal to a:
    A. centimetre
    B. metre
    C. decimetre
    D. kilometre

_____

41. A metric ton is equal to:
    A. 1 000 kilograms
    B. 100 kilograms
    C. 1 000 000 kilograms
    D. 10 kilograms

_____

42. The following is a base unit in SI metric:
    A. litre
    B. hectare
    C. second
    D. metric ton

_____

43. The modernized metric system consists of the following number of base units:
    A. 7
    B. 6
    C. 5
    D. 4

_____

44. In one metre there are the following number of millimetres:
    A. 10
    B. 100
    C. 1 000
    D. 0.001

_____

45. A teaspoon of cough syrup would equal about:
    A. 0.5 millilitre
    B. 1 millilitre
    C. 5 millilitres
    D. not sure

_____

46. Two inches equal how many millimetres?
    A. 39.8 mm
    B. 50.8 mm
    C. 35.7 mm
    D. 48.0 mm

_____

47. A hectare is equal to about:
    A. 2 acres
    B. 4 acres
    C. 2 1/2 acres
    D. 6 acres

_____

48. A millilitre is equal to:
    A. a cubic centimetre
    B. a cubic decimetre
    C. a cubic millimetre
    D. a cubic metre

_____

49. A measuring cup will hold about:
    A. 2 millilitres
    B. 25 millilitres
    C. 250 millilitres
    D. not sure

_____

50. A tall man would be about:
    A. 20 cm
    B. 200 cm
    C. 2 000 cm
    D. not sure

_____

Figure 3E-6b

PRE-TEST--TECHNICAL

1. The SI unit of force is (one right):
   A. newton
   B. pascal
   C. joule
   D. hertz

   _____

2. A mass of one kilogram would have a force of gravity at sea level of:
   A. 98 N
   B. 9.8 N
   C. 1.6 N
   D. 99.8 N

   _____

3. The force of gravity at Tranquility Base (on the Moon) on a mass of one kilogram would be:
   A. 9.8 N
   B. 1.6 N
   C. 3.2 N
   D. 8.1 N

   _____

4. The SI unit of pressure is:
   A. newton
   B. pascal
   C. joule
   D. coulomb

   _____

5. One psi is equal to approximately:
   A. 7 Pa
   B. 9 Pa
   C. 15 Pa
   D. 25 Pa

   _____

6. The SI unit of energy is:
   A. hertz
   B. joule
   C. pascal
   D. coulomb

   _____

7. The SI unit of power is:
   A. joule
   B. watt
   C. horsepower
   D. BTU

   _____

8. The SI unit of speed or velocity is:
   A. kilometre per hour
   B. metre per second
   C. kilometre per second
   D. metre per minute

_____

9. A large Calorie is equal to approximately:
   A. 8 joules
   B. 4.2 joules
   C. 10 joules
   D. 12 joules

_____

10. The SI unit of density is:
   A. grams per cubic metre
   B. kilograms per cubic metre
   C. kilograms per cubic decimetre
   D. grams per cubic decimetre

_____

11. The threads on a standard metric micrometer have a pitch of:
   A. 1 mm
   B. 0.5 mm
   C. 2 mm
   D. 0.2 mm

_____

12. A millimetre dimension of 0.01 mm is equal to approximately:
   A. 0.004 inches
   B. 0.0004 inches
   C. 0.04 inches
   D. 0.4 inches

_____

13. A tolerance of ten thousandths in the customary system would be equivalent to approximately:
   A. 0.025 mm
   B. 0.25 mm
   C. 2.5 mm
   D. 0.0025 mm

_____

14. The abbreviation for the International System of Units adapted in 1960 is:
   A. SI
   B. S.I.
   C. ISO
   D. MKS

_____

15. The symbol for the International Organization for Standardization is:
   A. ISO
   B. SI
   C. ISI
   D. ISM

_____

16. The metric A0 size paper is:
    A. 1 square yard
    B. 1 square metre
    C. 1 square foot
    D. 1 square decimetre _____

17. Compared to 8 1/2" x 11" paper, the A4 size is:
    A. shorter and wider
    B. narrower and longer
    C. narrower and shorter
    D. wider and longer _____

18. One sheet of A4 paper is equal in area to:
    A. 2 sheets of A3
    B. 2 sheets of A5
    C. 2 sheets of A6
    D. 1 1/2 sheets of 5 _____

19. ISO metric threads are available in:
    A. 2 series
    B. 3 series
    C. 4 series
    D. 5 series _____

20. In the thread designation shown as M5 x 0.8 the M means that it is:
    A. an ISO metric thread
    B. a metric thread
    C. a millimetre thread
    D. a metre thread _____

21. In the thread designation M5 x 0.8, the 5 means that:
    A. there are 5 threads to the inch
    B. the diameter is 5 millimetres
    C. the pitch is 5 millimetres
    D. it is the 5 series _____

22. In the thread designation M5 x 0.8, the 0.8 means that:
    A. the depth of the thread is 0.8 millimetres
    B. the pitch of the thread is 0.8 millimetres
    C. there are 8 threads to the centimetre
    D. there are 8 threads to the inch _____

23. In a thread designation 6P1.0, the P means that it is:
    A. a P series
    B. An OMFS thread
    C. that it is a pitch series
    D. that it is a preferred series _____

24. When dual dimensioning a drawing, the major or prime dimensions should be:
    A. first or above the line without brackets
    B. first or above the line with brackets
    C. second or below the line without brackets
    D. second or below the line with brackets _____

25. In engineering drawings, all dimensions should be in:
    A. millimetres and centimetres
    B. millimetres
    C. millimetres and metres
    D. millimetres, centimetres and metres _____

26. The four common reduction scales used in the U.S. for metric engineering drawings are:
    A. 1:1, 1:1.25, 1:5, 1:10
    B. 1:1, 1:2, 1:3, 1:5
    C. 1:1, 1:3, 1:5, 1:10
    D. 1:1, 1:4, 1:5, 1:10 _____

27. In converting inch decimal dimensions to metric decimal dimensions the metric dimensions should be rounded off to:
    A. 1 less number than the inch dimension
    B. 1 more number than the inch dimension
    C. equal number in both inch and metric
    D. none of the above _____

28. In redesigning a customary part to an all new metric part using hard conversion, a 1 inch dimension would be lised as:
    A. 25.4 mm
    B. 25 mm
    C. 2.54 cm
    D. 2.5 cm _____

29. The series of preferred numbers following geometric progression used in metric design are known as:
    A. pascal numbers
    B. renard numbers
    C. metric numbers
    D. ISO numbers _____

30. The ISO standards in metric measurements are available in approximately the following numbers:
    A. 10,000 - 11,000
    B. 150 - 200
    C. 50 - 100
    D. 10 - 15 _____

31. The following is a measurement-sensitive tool:
    A. hammer
    B. screwdriver
    C. micrometer
    D. pliers

_____

32. An electronic unit that can be added to a machine to provide dimensions both in inches and metrics is known as a:
    A. dual reading dial
    B. digital readout unit
    C. dual reading unit
    D. electronic calculator

_____

33. The following machine cutters would have to be replaced to machine a metric part:
    A. shell miller
    B. plain miller
    C. V-groove
    D. concave

_____

34. The recommended ISO module for building construction is:
    A. 100 mm
    B. 10 mm
    C. 300 mm
    D. 30 mm

_____

35. A 4' x 8' sheet of panel stock equals:
    A. 1200 x 2400 mm
    B. 1300 x 2400 mm
    C. 1220 x 2440 mm
    D. 1220 x 2400 mm

_____

Figure 3E-7

TEST SCORES OF SEMINAR PARTICIPANTS

Student	Beginning of Seminar		End of Seminar	
	Basic Test	Technical Test	Basic Test	Technical Test
1	-18	-26	- 2	- 4
2	-22	-20	-14	- 5
3	-21	-24	- 6	- 9
4	-27	-22	- 3	- 5
5	-26	-20	-12	-12
6	-11	-14	- 9	- 8
7	-20	-20	- 8	- 8
8	-29	-23	-18	-18
9	-10	-15	- 4	- 5
10	-17	-22	- 3	- 7
11	-14	-14	- 5	- 5
12	- 9	-23	- 4	- 5

Section 3

Part F

COST OF CONVERSION

Perhaps no area of metric conversion is more emotionally charged than that related to the cost of conversion. There has been a wide variety of estimates as to the overall cost of the United States to go metric. These have ranged all the way from $10,000,000,000 to $45,000,000,000. Those who oppose metric conversion usually use the larger figure while those in favor of metric conversion tend to use the lower figure. The Department of Defense, for example, has made an estimate of $18,000,000,000 for the cost of conversion for the various military areas.

However, there is no way of securing accurate estimates on the cost of conversion. This is true simply because it is difficult if not impossible to determine what should actually be included in conversion costs. For example, replacement of a piece of machinery may or may not be a metric conversion cost. If the machine is bought solely for the purpose of producing parts to metric standards, then perhaps the cost can be included. On the other hand, if the machine has been replaced in the normal cycle or to upgrade production facilities, this cannot be considered a conversion cost.

The question can logically be asked, What kind of costs should be included in metric conversion? For example, there are such items as the out-of-pocket payment for physical changes in things such as modifying scales or buying new ones, modifying lathes or buying new ones, altering gasoline pumps, adjusting or replacing machinery, repainting highway signs, and rewriting specifications and plans. They can also involve such intangibles as learning the new metric system and working more slowly in the metric system to avoid mistakes. Some of these costs can be greatly inflated. For example, one manufacturer estimated that the cost of training personnel would be $4,000 per person during the first year or a total of approximately twenty percent of the total growth of that industry. However, most manufacturing plants find that training costs are almost nonexistent, particularly for those persons on the production

line. Many of the large multinational farm machinery manufacturers have made the conversion from customary to metrics with almost no cost for retraining workers. All too often costs are inflated by those individuals who would like to discourage use of the metric system.

Most of the large multinational industries are converting to the metric system largely because they believe it would save the company money in the long run. The Director of Metric Conversion for the Honeywell Corporation of Minneapolis has estimated that the overall cost of metric conversion for that company will never exceed more than one percent of the gross sales of the products of that company for any of the ten years involved in the conversion of that company. Many of the large concerns expect to have substantial savings from converting to the metric system. This is the only logical reason why the multinational corporations are now converting. The excessive costs of operating on two different measuring systems, one for the United States and another for the rest of the world, has been the prime leader in convincing these large corporations that they should convert to the metric system.

Substantial savings are being expected of metric conversion in the areas of drafting and design, product standardization, reduced inventory, and in many other aspects of the business. For example, the United States' industries have developed an Optimum Metric Fastener System, now called the modified ISO series, which has only twenty-five different diameters of threaded fasteners. Use of these threaded fasteners will reduce the size and variety from somewhat over several hundred to as few as twenty-five or less. This will be a substantial savings to the industry.

It is not the purpose of this study to be concerned with the overall costs of metric conversion. These are more properly the responsibility of other organizations. However, there is a great deal of misinformation and unjustifiable estimates of costs of conversion for education. It is obvious for example, that all instructional materials including textbooks, workbooks, references and non-print materials that involve measurement must be changed if education is to move from the customary (English) to the metric system. The question can be logically asked, Can the cost of changing textbooks to the metric system be assumed to be a metric conversion cost or should it more properly be included in the normal replacement of instructional material cost?

Most publishers of written instructional material operate on a five to seven year cycle, which is typical of the adoption period of many cities and states. Regardless of whether the United States converts to the metric system, most books used in schools will be changed after this cycle period. Therefore, converting to the metric system will not be necessarily an added cost to the publisher. In the early stages of conversion there may be some additional costs to the publisher due to the fact that they may want to include metrics in a three-stage conversion process. For example, the first stage might include keeping the customary system as the major measuring system of the text and adding the metric system in parentheses after every measurement. The second stage may be to include the metric measurement first with the customary measurement in parentheses behind each measurement, and the third stage may be an all metric textbook. Obviously the cost of conversion to the metric system will be much more expensive without a national policy than with one. Publishers who are uncertain as to how fast and when school systems will convert to the metric system will not be able to plan as carefully on their revision cycles as if there were a national metric converstion act which set up specific time line dates and times for conversion.

CONVERSION COSTS IN INDUSTRIAL EDUCATION

An estimate of the total cost of conversion for various areas in industrial education is difficult to obtain simply because a great deal depends on the type and expense of the conversion in each shop or laboratory. A good example of this would be the concern with the problem of metric conversion in the area of industrial education that would perhaps be most costly, mainly in the area of machine shops. It has generally been estimated that there are approximately fourteen thousand machine shops in schools in the United States. Obviously the cost of conversion of all the educational machine shops in the United States might range anywhere from $42,000,000 to $840,000,000. The low end of this conversion figure would be for machine shops in which the total cost of conversion would be:

1. A complete set of hand tools such as is listed in the attached for a total cost of approximately $1,000 per school.
2. Two sets of dual reading dials at $250 per set plus one set of conversion gears for cutting metric threads.

3. One $1,200 to $1,500 digital readout unit for a metric conversion of a milling machine.

With this limited conversion there would be the adequate measuring tools and other hand tools necessary to do metrics as well as two lathes on which metric training could be done plus one milling machine. At a cost of approximately $40,000 to $60,000 per lab all equipment could be converted to metrics with the addition of at least one new lathe that has all metric capabilities.

The problem of metric conversion is complicated by the fact that there are various ways in which conversion can be done in each of the technical areas. For example, there are at least four basic ways of providing metric capabilities for a milling machine. These are as follows with the estimated cost.

1. Adding two dual reading dials each to the milling machine at a cost per unit of approximately $100 for the dial and $50 for installation costs for a total conversion cost of $250.
2. Replacing feed screws and nuts with metric units and adding metric dials. This can be done for an overall cost of $300 to $600 per milling machine.
3. Adding a mechanical dual reading unit to the machine. This unit that passes to the movable parts of the machine could be added at a cost of approximately $500 to $600.
4. Adding a digital readout unit. This would be more typical of what small industrial machine shops will do, and the cost would be from $1,200 to $1,500 per milling machine.
5. The last alternative would be, of course, to purchase an entirely new milling machine with total metric capabilities at a cost of anywhere from $8,000 to $20,000. This latter alternative is one that cannot be included in metric conversion costs.

The four basic machines used in most school laboratories are drilling machines, lathes, milling machines and grinders. In general costs are as follows:

1. Drilling machines - This cost will be negligible and may include only adding a piece of sensitized metric tape over the depth gauge or replacing the depth gauge with a metal one at a cost of $2.00 to $5.00
2. Lathes - The least expensive conversion for a lathe would be approximately $300. This will include two dual reading dials and conversion gears for cutting metric threads. If the lead and feet screws are replaced and new metric dials added plus changes for gearing, costs will be in the range of $600 to $1,000. The cost

for an all metric lathe will range from $5,000 to $10,000 per unit.

3. Milling machines - Conversion costs will range from approximately $350 per unit for dual reading dials to $1,500 per unit for digital readout units.

4. Grinding machines - Conversion costs will be from $250 to $300 for dual reading dials to $1,500 for digital readout units.

Perhaps the least expensive industrial education facility to convert is the drafting room. It has been estimated that there are at least 20,000 drafting rooms in the United States and the total cost of conversion in this area includes only replacing scales and templates. Desirable equipment might include the addition of some precision measuring tools such as micrometers, vernier calipers, etc. The total cost of replacing scales and templates for an average room will be less than $100 so that the overall cost of converting all the drafting rooms in the United States would be between $200,000 and $250,000. While eventually drafting tables and reproduction equipment may be made to metric standards, these cannot be included in any metric conversion costs.

Conversion of Building Construction and Woodworking

Another area that will be relatively inexpensive to convert is the total area of woodworking and building construction. The only essential tools that will need replacing are those used for measuring including rules and scales. There is no need to replace any equipment. The only conversion needed on woodworking machines is to change the depth indicators. This can be done either by covering the existing one with metric pressure-sensitive tape or replacing the metal depth indicator. The overall cost of converting a laboratory could be between $100 an $150 depending on how extensive the amount of measuring tools needed is. Approximately 22,000 woodworking labs in the United States would total a conversion cost in the area of $200,000 to $300,000.

The woodworking area clearly illustrates the problem of estimating total conversion costs. The carpenter's union has estimated that it will cost approximately $300 for each tradesman to replace his tools. However, in this estimate they have included many non-measuring tools such as hammers, center punches, auger bits, and other tools that do not require replacing. Their total estimate for conversion for one million carpenters is approximately $300,000,000. Obviously most of these costs cannot be attributed to metric conversion.

Conversion of General Metals

The cost of conversion of general metals labs will depend to a large extent on whether or not machine tools are included in the lab. Assuming that machine tools are in a separate laboratory then the overall cost of conversion in general metals will be relatively small. The cost of hand tools will be approximately $125 per laboratory. The estimated cost for the 16,000 general metals labs in industrial education would be approximately $200,000 to $220,000. This does not include any costs for equipment. All sheet metal equipment will only require the replacement of the depth or length indicators with sensitized metric tape or new metal tape. There will be no conversion costs in the areas such as welding, foundry, forging and metal plating.

Conversion of Auto Mechanics

The auto mechanics instructional program must reflect industry, and therefore, costs of conversion in this area cannot normally be attributed to metric conversion. This is because currently thirty percent of all the automobiles in the United States use metric fasteners. Therefore, the average auto mechanic's laboratory must have sets of metric wrenches to work on cars. Therefore, the cost of purchasing new metric wrenches cannot be included in total conversion costs. Eventually the dial faces of much of the testing equipment will require replacing when SI units are used for all standards of measurement; for example, when horsepower is replaced by watts, energy by joules, and pressure by kilopascals. However, these changes will be made during the normal replacement of such testing equipment and for many years the faces of these dials will be printed with dual reading scales.

The question of costs of conversion in industrial education are as complex as those for industry in general. It is impossible to give any specific authoritative figure on overall costs of conversion because so many factors must be included in these areas. Much of the costs of conversion can be done during the normal replacement of software including textbooks, workbooks, and other materials used in instructional programs. The costs of metric hand tools can also be budgeted in normal replacement patterns of workshops or laboratories. The major costs of metric conversion will be in the area of machine shop. It is also difficult to determine the costs of inservice training for teachers so that they can utilize the metric system successfully. Much of the preservice

instruction will or should be included in teacher education as a formal change in educational technology. Certainly no one would consider adding a conversion cost in teacher education for utilizing more performance objectives.

The same could be said that no conversion costs should be included for using more SI metric units rather than customary units. It is undoubtedly true that without some kind of federal assistance and without overall plans and commitments, metric conversion in industrial education will be spotty. Some individual school districts who see the potential for improving career-oriented programs for industry will make every effort to convert to the metric system. Others who are not so concerned about the student's ability to hold jobs in industry may not be greatly concerned.

By the time the industrial education program begins to think seriously about metric conversion of tools and machines, a great deal of experience will be available from Canadian schools. Most canadian schools plan to have all metric conversion completed by 1978. Some of the technical institutions made complete conversion of their machine shops during the school year 1974-1975. Others plan to complete their conversion during 1975-1976.

At 1974 prices it has been estimated in Canada that a machine shop can be converted for approximately $40,000. This includes complete conversion of all lathes and milling machines as well as the necessary hand tools. The cost of conversion obviously will increase with each year of delay in completing the conversion process. It has been estimated by Battell Institute that if metric conversion implementation is delayed from the 1970's to the 1980's that the overall increase in cost of conversion will be approximately fifty percent higher.

CASE STUDIES

The following are three case studies of institutions and governmental agencies who made a study of the costs of conversion in industrial education.

1. Western Michigan University - The Industrial Education Department at Western Michigan University became cognizant of the need to convert tools and machines to metric capabilities as a result of this federally-funded project. Therefore, funds were made available from

departmental resources to purchase major conversion items and new equipment that had metric capabilities. These major investments were made during the calendar year 1974. Any school using these cost figures as guidelines can expect an approximate ten percent increase in the cost of each item per year.

Approximately $11,000 was spend in the machine shop area as follows:

1. A compete set of hand tools as recommended by the material provided in the federal project--$900.
2. Metric dual reading dials to convert two lathes and one milling machine--$1,000.
3. One digital readout system for a vertical milling machine--$1,600.
4. One fifteen inch all metric lathe--$7,500.
5. One set of gears for cutting metric threads--$150.

Examples of the actual Western Michgian University Purchase Orders appear as Figures 3F-1, 3F-2, 3F-3 and 3F-4.

As a result of these expenditures, the machine shop added metric capabilities by converting two lathes, purchasing one new lathe and converting two milling machines, one with dual reading dials and one with a digital readout unit. To convert all of the lathes with dual reading dials (the laboratory has twenty) would cost an additional $5,000 and to convert the other five milling machines with digital readout units would have cost another $10,000.

The conversion of the drafting lab was accomplished with an expenditure of less that $200 and a like amount was spent in the woodworking laboratory.

2. Ferris State College - The School of Technical and Applied Arts at Ferris State College in Big Rapids, Michigan, surveyed the cost of making a complete conversion of their machine tool department. Their conversion cost for approximately thirty-eight major machine tools plus measuring tools was $60,000. Detail of their recommendations (again with 1974 prices) appears as Figure 3F-5.

3. Conversion Costs for Industrial Education in the Province of Alberta - In 1974 Province funds were obtained to make a metric conversion cost study for industrial education in the Province of Alberta. This study investigated SI metric conversion costs in the

career fields of visual communications, mechanics, construction and fabrication, electricity/electronics and personal services. All thirty-nine schools in Alberta which offer courses in these fields were included in the study. The final SI conversion total costs for the Province, assuming all items of potential conversion would be replaced or modified, was over one million dollars. On a basis of a five-year conversion plan, the first year costs would be $200,000.

The two career areas in which most of the conversion costs will fall are mechanics (including machine shop) and construction and fabrication. The areas of automotive and machine shop account for approximately sixty-five percent of the total conversion costs.

Figure 3F-1

TAX FREE REGISTRY NO. A-154961

WESTERN MICHIGAN UNIVERSITY

KALAMAZOO, MICHIGAN 49001

PURCHASE ORDER

ORDER No. 44633 P

P.O. DATE 3-6-74

REQUISITION NO.	REQ. DATE	FUND	ACCOUNT NUMBER	SHEET NO.	BUYER
452		General 11	01 10 01 4850	1	Leak

Dist: Industrial Education
Dr. John Feirer
del. to IET Bldg. Rm 2090 (Fillingham)

Stavely Machine Tools, Inc.
34 Tower Street
Hudson, Ma.01749

SHIP TO
P.O. ADDRESS
FRT. ADDRESS
SHIP VIA

Western Michigan University
Receiving Department
Oakland at Stadium Drive
Kalamazoo, Michigan 49001

TERMS Net 30 days

F.O.B. Delivered

SHIP 2-3 Weeks ARO

DUPLICATE COPY

ITEM NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	4	EA	Inch, Metric Conversion Dial, Lead Screw of .100, Small Box, Adaptor Dimension of 1 5/8 dia. with ½" bore, top reading.	$ 145.00	$ 580.00
	2	EA	Inch, Metric Conversion Dial, Lead Screw of .200, small box, adaptor dimension of 1 5/8 dia. with ½" bore, top reading.	145.00	290.00
	1	EA	Inch, Metric Conversion Dial, lead screw of .100 small box, adaptor dimension of 1 5/8 with ½" bore, top reading.	145.00	145.00
			TOTAL		$1015.00
			AS PER YOUR QUOTATION DATED TO OUR BID #44633		

INSTRUCTIONS

SUBMIT INVOICE IN DUPLICATE ON YOUR OWN COMPANY INVOICE FORMS. MAIL INVOICE TO ACCOUNTS PAYABLE, TREASURER OF THE UNIVERSITY.

PURCHASE ORDER NUMBER MUST BE PLAINLY NOTED ON EACH INVOICE, VOUCHER, ON ALL PACKAGES AND SHIPPING TAGS, AND IN CORRESPONDENCE PERTAINING TO ORDER.

PERMIT SEPARATE INVOICE FOR EACH PURCHASE ORDER PROMPTLY UPON SHIPMENT.

ALL CORRESPONDENCE RELATING TO THIS ORDER SHOULD BE ADDRESSED DIRECTLY TO THE PURCHASING DEPARTMENT.

PACKING LIST MUST BE INCLUDED WITH EACH SHIPMENT.

THIS ORDER REPRESENTS ACCEPTANCE OF YOUR WRITTEN BID AND CONSTITUTES THE CONTRACT BETWEEN US.

NO GOODS WILL BE ACCEPTED C.O.D.

ORDERS MUST BE ACKNOWLEDGED PROMPTLY.

WHEN SHIPMENT IS F.O.B. SHIPPING POINT, FREIGHT MUST BE PREPAID AND ADDED TO INVOICE.

NON DISCRIMINATION CLAUSE In the performance of any contract or purchase order, the bidder agrees not to discriminate against any employee or applicant for employment, with respect to his hire, tenure, terms, conditions or privileges of employment, or any matter directly or indirectly related to employment, because of race, color, religion, national origin, ancestry or age. The bidder further agrees that every subcontract entered into for the performance of any contract or purchase order resulting hereby will contain a provision requiring non-discrimination in employment as herein specified, binding upon each subcontractor. This covenant is required pursuant to section 3.548 of the Annotated Public Acts of the State of Michigan of 1955 and any breach thereof may be regarded as a material breach of the contract or purchase order.

ISSUED BY: WESTERN MICHIGAN UNIVERSITY
PURCHASING DEPARTMENT - KALAMAZOO, MICHIGAN

M. D. Kerby
DIRECTOR OF PURCHASING

BY

Figure 3F-2

TAX FREE REGISTRY NO. A-154961

WESTERN MICHIGAN UNIVERSITY

KALAMAZOO, MICHIGAN 49001

PURCHASE ORDER

ORDER No. 44627 P

P.O. DATE 3-8-74

QUISITION NO.	REQ. DATE	FUND	ACCOUNT NUMBER	SHEET NO.	BUYER
1453		General 11	01 10 01 Var.*	1	Leak

Dist: Industrial Education
Dr. Feirer
del. to IET Bldg. Rm 2090 (Hall)

Kandler Machinery
618 East Michigan Avenue
Kalamazoo, Michigan

SHIP TO
P.O. ADDRESS
FRT. ADDRESS
SHIP VIA

Western Michigan University
Receiving Department
Oakland at Stadium Drive
Kalamazoo, Michigan 49001

TERMS Net 30 days

F.O.B. Delivered

SHIP Approx. 60 days

DUPLICATE COPY

M O	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
			Anilam Linear Glass Scale Digital Readout System, Series BT, 2-Axes for our Index 856 Milling Machine. SPECIFICATIONS: RESOLUTION .0005" System consists of 2-axes 6 Digits per Axis Readout Display Pushbutton "zero" reset Plus and Minus Signs MSI/TTL Integrated Circuits (2) Linear Glass Scale Encoders, factory pre-aligned, in protective housing ready for mounting - no field calibration required. ACCURACY: .0005" over entire range of travel.		
	1	EA	Series BT 2-Axes Linear Glass Scale System for Index 856 Milling Machine, S/N #14275, 12" x 30" Travel, 42" Table.		$ 1290.00
	1	EA	Universal Mounting Brackets for Index		50.00

CONTINUED.....

INSTRUCTIONS

UBMIT INVOICE IN TRIPLICATE USE YOUR DUPLICATE COPY AS INVOICE FORMS SHALL NVOICE TO ACCOUNTS PAYABLE DEPARTMENT OF THE UNIVERSITY

URCHASE ORDER NUMBER MUST BE PLAINLY NOTED ON EACH INVOICE VOUCHER ON LL PACKAGES AND SHIPPING TAGS AND INVOICE CORRESPONDENCE PERTAINING TO ORDER

UBMIT SEPARATE INVOICE FOR EACH PURCHASE ORDER PROMPTLY UPON SHIPMENT

L CORRESPONDENCE RELATING TO THIS ORDER SHOULD BE ADDRESSED DIRECTLY TO HE PURCHASING DEPARTMENT

ACKING LIST MUST BE INCLUDED WITH EACH SHIPMENT

HIS ORDER REPRESENTS ACCEPTANCE OF YOUR WRITTEN BID AND CONSTITUTES THE ONTRACT BETWEEN US

O GOODS WILL BE ACCEPTED C.O.D.

RDERS MUST BE ACKNOWLEDGED PROMPTLY

HEN SHIPMENT IS F.O.B. SHIPPING POINT, FREIGHT MUST BE PREPAID AND ADDED TO NVOICE

NON DISCRIMINATION CLAUSE In the performance of any contract or purchase order resulting hereunder, the parties hereto agree not to discriminate against any employee or applicant for employment with respect to his hire, tenure, terms, conditions or privileges of employment, because of his race, color, religion, national origin, ancestry or age. The parties further agree that every non-discrimination clause required by the performance of any contract or purchase order resulting hereunder shall contain a provision requiring non-discrimination in employment, as herein specified, binding upon each subcontractor. This covenant is required pursuant to Section 9 of Act No. 251 P.A. Acts of 1955, and this Act is a part of every contract or purchase order and its breach shall be regarded as a material breach of the contract or purchase order.

ISSUED BY: WESTERN MICHIGAN UNIVERSITY
PURCHASING DEPARTMENT - KALAMAZOO, MICHIGAN

M. D. Kerby

DIRECTOR OF PURCHASING

BY

WESTERN MICHIGAN UNIVERSITY

KALAMAZOO, MICHIGAN

PURCHASE ORDER–Continuation Sheet

ORDER NO. 44627P

BUYER	REQ. DATE	FUND	ACCOUNT NUMBER	SHEET NO.	REQUISITION NO.
ak ls		General 11	01 10 01 Var.*	2	41453

ITEM NO.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	Wall Bracket		4.75
	1	EA	Inch Metric Conversion (flip of switch)		250.00
	1	EA	Starrett Metric Tools, No. 196MA, Universal Dial Test Indicator.		35.00
	1	EA	Screw Pitch Gage. No. 158M		6.20
			TOTAL		$ 1635.95
			AS PER YOUR QUOTATION DATED 3/2/74 TO OUR BID #44627.		

200-PA REV. 8-69

Figure 3F-3

STATE OF MICHIGAN
DEPARTMENT OF ADMINISTRATION—PURCHASING DIVISION
LANSING, MICHIGAN 48913

PURCHASE REQUISITION

BUYER	REQ. DATE	ACCOUNT NAME	ACCOUNT NUMBER	SHEET NO.	REQUISITION NO.
2 - Brewer	5-24-74	General 11	01 10 50 4850	1	46009

Lakeshore Machinery & Supply
450 West Hackley
Muskegon, Michigan 49443

I hereby certify that the requested articles are necessary; are for a purpose included within the budget and appropriation, or otherwise authorized for this agency; and payment therefore represents a proper charge against the account shown above.

SIGNED, AUTHORIZED AGENT _____ $ _____ TOTAL EST. COST

SHIP TO
. ADDRESS
T. ADDRESS

Western Michigan University
Receiving Department
Oakland at Stadium Drive
Kalamazoo, Michigan 49008

GROUP NO._____ DELIVERY REQUIRED

Western Michigan University
NAME OF DEPARTMENT OR INSTITUTION

DATE

QUANTITY	UNIT	MICHIGAN COMMODITY NO.	DESCRIPTION	UNIT PRICE	AMOUNT
1	EA	2800	Clausing Cohchester 15" Geared Head Engine Lathe 30" C.C. Fully Metric Model No. 8030M with standard equipment as described in Catalog No. 2308 460 volt. To be fully installed in Room 2098 I & ET Bldg. Vendor to furnish proof of insurance before installation. MUST MEET ALL EXISTING FEDERAL AND STATE SAFETY STANDARDS. DUPLICATE COPY		$ 7450.00
			TOTAL		$ 7450.00

PURCHASING DIVISION WORK COPY—FOR PURCHASING DIVISION USE ONLY

BIDDERS

F.O.B. SH. PT.

F.O.B. DEL'VD.

BUYER'S SIGNATURE

APPROVED — STATE PURCHASING DIRECTOR

DATE RECEIVED PURCHASING DIV.

DATE RELEASED BUYER

249

DATE RECEIVED BY BUYER

DATE RELEASED ORDER WRITING

175

Figure 3F-4

TAX FREE REGISTRY NO. A-154961

WESTERN MICHIGAN UNIVERSITY

KALAMAZOO, MICHIGAN 49001

PURCHASE ORDER

ORDER No. 53503 P

P.O. DATE 9-3-74

QUISITION NO.	REQ. DATE	FUND	ACCOUNT NUMBER	SHEET NO.	BUYER
1518		Industrial Educ. 22	01 17 46 4848	1	Leak

Dist: Industrial Education
Dr. John Feirer
del. to IET Bldg. Rm 2098 (Hall)

Kandler Machinery Co.
618 East Michigan
Kalamazoo, Michigan

SHIP TO
P.O. ADDRESS
FRT. ADDRESS
SHIP VIA

Western Michigan University
Receiving Department
Oakland at Stadium Drive
Kalamazoo, Michigan 49001

TERMS Net 30 days

F.O.B. Delivered

SHIP 30 days ARO

DUPLICATE COPY

EM O.	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
	1	EA	10" 2 pc. 3 jaw chuck 1023523	$ 432.00	$ 432.00
	1	EA	10" in. 4 jaw chuck 1014523	317.00	317.00
	1	EA	7355 Live center	42.50	42.50
	1	EA	15-755 Steady Rest	163.00	163.00
			TOTAL		$ 954.50

These parts are for the Clausing Colchester
15" Geared Head Engine Lathe 30" C.C.
Fully Metric Model No. 8530.

PRICES IN EFFECT AT TIME OF SHIPMENT WILL APPLY.

AS PER YOUR QUOTATION DATED 8/27/74 TO OUR BID #53503

INSTRUCTIONS

[illegible]

NON DISCRIMINATION CLAUSE. In the performance of any contract or purchase order resulting hereform, the bidder agrees not to discriminate against any employee or applicant for employment, with respect to his hire, tenure, terms, conditions or privileges of employment, or any matter directly or indirectly related to employment, because of race, color, religion, national origin, ancestry, or sex. The bidder further agrees that every subcontract entered into for the performance of any contract or purchase order resulting therefrom will contain a provision requiring non-discrimination in employment, as herein specified, binding upon each subcontractor. This covenant is required pursuant to Section 4 of Act No. 251 of the Public Acts of the State of Michigan of 1955 and any breach may be regarded as a material breach of the contract or purchase order.

ISSUED BY: WESTERN MICHIGAN UNIVERSITY
PURCHASING DEPARTMENT · KALAMAZOO, MICHIGAN

M. D. Kerby

DIRECTOR OF PURCHASING

BY

Figure 3F-5

REPORT AND RECOMMENDATIONS
METRIC CONVERSION GRANT

This report is not complete because all necessary information cannot be secured as of this date; some manufacturers are still working on the means of converting their products to the metric system and responses to all letters sent out have not been returned.

However, there is enough information to make this report and recommendations very meaningful and there is sufficient evidence to indicate a definite direction in which the School of Technical and Applied Arts should move.

A complete inventory of the equipment in the Machine Tool Department reveals that 38 major machine tools can be converted to the metric measuring system. Nine machine tools cannot be changed and 34 machines do not need to be changed as they can be used as presently equipped. An inventory of the measuring and gaging equipment indicates that six gages will need to be changed, three items are too costly to change and two items cannot be converted. The tools that are not changed will need to be replaced when the conversion to metrics is completed. Small precision instruments will need to be purchased to start training in metrics and when complete change is made, students will purchase their own instruments. A stock of cutting tools must be purchased to start the training program.

The minimum change which is recommended to be made in 1974 is one lathe, converted ($400.000); one Bridgeport Mill, converted ($495.00); one Surface Grinder, converted ($275.00); one set Gage Blocks, purchased ($68.50); one Millimeter Mike, purchased ($27.75); and one Dial Test Indicator ($57.00). This total would be $1,323.25.

RECOMMENDATIONS

From the information tabulated, it is evident that a complete conversion to the metric system will need to be made in the machine tool area. It is recommended that this conversion be completed within the next five years. Chart I indicates the time and cost schedule for this change with reference to the Machine Tool lab equipment. A recommended list of standard and precision tools are included on Chart II and Chart III.

A recommendation to appoint a Metric coordinator and school-wide committee for the School of Technical and Applied Arts is imperative. This committee could start by reviewing, editing, and distributing information for the assimulation of all Technical and Applied Art faculty. Interviews with personnel from industry and the American National Metric Council indicates that education must begin to plan and train faculty now for the teaching of metrics (SI units) in all classes.

The following recommendations were made by Mr. John Lindbeck, National Chairman of the Coordinating Committee on Education and Industrial Training of the American National Metric Council:

1. That the Dean of the School of Technical and Applied Arts provide a training program for all faculty members.
2. That the School decide what training must be done for students in each curriculum; that each course have at least one SI metric unit by Fall, 1975.
3. That the College provide in-service training for students who are in the field.
4. That the School set a target date of Fall, 1975, for the introduction of metrics to all technical students.
5. That a learning resource center be established for the School or possibly for the entire college.
6. That a method for evaluating training be established.

It was further suggested by Mr. Lindbeck and Mr. Elias Scheibe, Administrative Engineer, Diesel Equipment Division, G.M.C., that at least one full metric drawing be made in all technical drafting classes by Fall term of 1975, with the intention of going to all drawings in metrics. It was suggested that dual dimensioning not be taught as this plan was tried by G.M.C. and Caterpillar and discarded.

CHART I RECOMMENDED CHANGES

MACHINE	INVENTORY TAG	DATE OF CHANGE/ESTIMATED COST 1974	1975	1976	1977	1978
LeBlond Lathe 17"	8374	$400	$400			
LeBlond Lathe 15"	8376			$1,150		
LeBlond Lathe 15"	8375			$1,150		
LeBlond Lathe 15"	8377				$1,200	
LeBlond Lathe 15"	39796		$1,150			
Sheldon Lathe 15"	30179		$ 837			
Sheldon Lathe 15"	30180		$ 837			
Sheldon Lathe 15"	30181				$ 850	
Sheldon 17" Variable Speed	21638			$ 500		
Sheldon 13" Variable Speed	21835			$ 857		
Harrison Lathe 11"	22672			$ 800*		

*Estimated - No Report From Company

MACHINE	INVENTORY TAG	DATE OF CHANGE/ESTIMATED COST 1974	1975	1976	1977	1978
Harrison Lathe 12"	22673				$ 850*	
Harrison Lathe 12"	22674					$ 900*
Harrison Lathe 12"	22675					$ 900*
Harrison Lathe 12"	23182					$ 900*
Hendey 16" lathe			REPLACE			$10,000*
Hendey 16" Lathe			REPLACE			$10,000*
Bridgeport Mill	18841			$ 700		
Bridgeport Mill	31099		$ 650			
Bridgeport Mill Read Out	39768				$1,050	
Bridgeport Mill	31049		$ 650			
Bridgeport Mill	39767			$ 700		
Bridgeport Mill Slotter Attachment	23755	$495				

*Estimated - No Report From Company

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MACHINE	INVENTORY TAG	DATE OF CHANGE/ESTIMATED COST 1974	1975	1976	1977	1978
Index Vertical Mill	8363			$ 750		
Index Horiztonal Mill	39421		$ 806			
Harrison Horizontal Mill	23709				$ 600*	
Greaves Horitontal Mill	8365			$1,500*		
K & T Vertical Mill	8364				$1,500*	
Cincinnati Dial Horizontal Mill	8361			$ 600		
Surface Grinder Reid	8330		REPLACE			$ 4,000*
Surface Grinder G & L 25	8332		$ 290			
Surface Grinder G & L 20	40048	$275				
Surface Grinder Brown & Sharpe 6' x 18			$ 600*			
Surface Grinder Thompson 12 x 24				$ 800*		
Cincinnati O.D. Grinder	8351				$1,200*	

*Estimated - No Report From Company

MACHINE	INVENTORY TAG	DATE OF CHANGE/ESTIMATED COST 1974	1975	1976	1977	1978
Majestic O.D. ID Grinder	8334		$ 252			
Landis OD Grinder 10			$1,200*			
Norton OD Grinder 10				$1,200*		
Cincinnati No. 2 Tool & Cutter Grinder	8331		$ 550			
Cincinnati No. 2 Tool & Cutter Grinder	8305		$ 550			
Cincinnati No. 2 Tool & Cutter Grinder	39428				$ 600	
Cincinnati No. 2 Tool & Cutter Grinder						$ 600
Rockford Hydraulic Shaper	8368		$ 793			
G & E Shaper Universal Table	8369	NO CHANGE		REPLACE		$ 4,000*
Steptoe 14" Shaper	39422	NO CHANGE		NO PARTS		
Linley Jig Borer	33255			$ 600		
E.D.M. Machine	31423	NO CHANGE		USE AS IS		

*Estimated - No Report From Company

MACHINE	INVENTORY TAG	DATE OF CHANGE/ESTIMATED COST 1974	1975	1976	1977	1978
Jones & Lamson Company	8373	NO CHANGE		TOO OLD		
Do-All Transcheck	26364		$ 50*			
Pratt & Whitney	8455		$ 20*			
Ele. Gage	8456			$ 20		
Johansson Company	8459	NO CHANGE				
Johansson Company	8458	NO CHANGE				
Scherr, Opt. Company	35635		$ 196			
Edmunds Air Gage	35139		$ 10			
Sheffield Shawdow Company	8460		$ 20			

*Estimated - No Report From Company

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CHART II MEASURING TOOLS (EQUIPMENT)

MACHINE	INVENTORY TAG	DATE OF CHANGE/ESTIMATED COST 1974	1975	1976	1977	1978
Micrometers		$ 27.75	$ 60.00	$ 96.00	$ 152.50	
Checking Standards			$ 3.50			
Dial Calipers			$ 267.00			
Gage Blocks		$ 68.50			$ 495.00	
Dial Test Indicator		$ 57.00	$ 190.00			
Thread Wires			$ 20.00	$ 40.00		
Screw Pitch Gage			$ 7.50			
Sine Bar				$ 25.00		
Micrometer Depth Gage			$ 36.00			

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MACHINE	INVENTORY TAG	DATE OF CHANGE/ESTIMATED COST 1974	1975	1976	1977	1978
Tooling for Holding Cutting						
Tools (Mill, Collets, etc.)			$ 200.00	$ 200.00		
TOTAL FOR CHARTS I AND II		$1,323.75	$10,645.00	$9,388.00	$7,297.50	$31,300.00
GRAND TOTAL		$59,954.00				

CHART III CUTTING TOOLS (CS & SM)

TOOL DESCRIPTION	SIZE	QUANTITY	COST	TOTAL
Plug Tap	M 3 x .6	6	$ 3.05	$ 19.00
Plug Tap	M 3 x .5	6	3.05	19.00
Plug Tap	M 3.5 x .6	6	2.80	16.80
Plug Tap	M 4 x .7	6	2.80	16.80
Plug Tap	M 6 x 1	6	3.05	18.30
Plug Tap	M 8 x 1.25	6	3.20	19.20
Plug Tap	M 10 x 1.25	6	4.60	27.60
Plug Tap	M 12 x 1.5	6	5.10	30.60
Plug Tap	M 16 x 2	6	6.70	40.20
Plug Tap	M 20 x 2	3	13.40	40.20
Drills for Taps	2.5 mm	6	.44	2.64
Drills for Taps	2.6 mm	6	.44	2.64
Drills for Taps	3.0 mm	6	.44	2.64
Drills for Taps	3.4 mm	6	.56	3.36
Drills for Taps	5.2 mm	6	.62	3.72
Drills for Taps	7.0 mm	6	.95	5.70
Drills for Taps	10.72 mm	6	2.10	12.60
Drills for Taps	14.28 mm	3	4.27	12.81
Drills for Taps	18.25 mm	3	5.12	15.36
Drill Sets	1 mm to 10 mm	3	25.50	76.50
Reamers				108.40
End Mills				72.00
TOTAL				$566.00

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CHART IV MACHINE TOOLS NOT TO BE CONVERTED

MACHINE	INVENTORY TAG
Drill Press	8344
Die Filer	8346
Sunmer Hone	8348
Tap Grinder	8349
Belt Finisher	8381
Peerless Hacksaw	8382
Drill Press	8384
Grinder	8385
Plantograph	8388
Drill Press	8389
Drill Press	8393
Tool Shaper	8399
Arbor Press	8421
Bench Center	8445
Radius Dress	8464
Engraver	8557
Drill Press	24370
Punch Press	25775

MACHINE	INVENTORY TAG
Cut Off Saw	25776
Drill Press	28013
Cut Off Saw	26361
Band Saw	29644
Band Saw	33011
Drill Press	34527
Drill Press	35019
Drake Arbor Press	39625
Drill Press	14586
Carbide Grinder	8362
Hammond Grinder	8341
Hammond Grinder	8387
Baldor Grinder	8401
B & D Grinder	22279
B & D Grinder	22280
Grinder	22610
Drill Grinder	8556

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CHART IV CONT'D. GAGES AND MEASURING TOOLS

MACHINE	INVENTORY TAG
Surface Plate	8457
Surface Plate	8463
Hardness Tester	9754
Scope Comparator	22676
Pressure Tester	33263
Testing Machine	33265
Impactor Tester	33266
Unit Vibroniet Polisher	35197
Vibroniet Unit	35198
Vibroniet Unit	35199
Hardness Tester	8461
Hardness Tester	8462
Ductility Tester	21889
Surface Plate	8472
Shore Hardness	35280

TESTIMONIALS

Mr. Edward Loeffler, Technical Director, National Machine Tool Builders Association:

> "The emphasis is shifting to metric; it is never too soon to start to learn the metric system. All new replacements should be metric. Consider dual system equipment for present."

Mr. Strang, Caterpillar Tractor Company, Supervisor of Engineering Standards:

> "We saved ourselves some considerable trouble by realizing quite early that converting existing inch drawings to metric terms accomplishes nothing and costs plenty. Dual dimensioning as an aid to conversion is self-defeating; machine operators merely ignore the metric dimension."

Mr. Everett Baugh, Evecutive Engineer in charge of Metric Planning Activity of General Motors:

> "Here's how General Motors is conducting its employee training:
> 1. An awareness program.
> 2. Training sessions are organized for those who will use the metric system on their jobs.
> 3. Instruction is conducted as though it were a very simple language change.
> 4. Use of internationally agreed terms and spelling is stressed.
>
> The G.M. guidelines include: new developments will be metric from the start. This includes items now in the development state. Service parts now in production will remain as is. In the interim before complete metrification is accomplished, some Capitol equipment with dual measuring capability will be required."

Mr. Robert H. Welty, Training Director, Weldun Company, Bridgeman, Michigan:

> "Of one thing I am certain, it will be definitely much easier for them to learn it in school than wait until they are on the field."

This is a statement from a letter viewed in answer to a request made in letters to the Machine Tool Advisory Committee.

Mr. Fred Zwald, General Manager, Oliver Machinery Company:

> "You have taken the first and most important step in training them in the use of metrics by converting your machines to metric screws. I feel that the boys you will be starting in the Fall of 1975, and, in fact your present group, probably do not have much basic understanding of the metric system other than their mathematical education in decimals. I would, therefore, conclude that some work in the general understanding of metrics as it applies to their daily lives, as well as the work environment, would certainly be in order. Much of the industry that your students will enter in 1977, will be producing in metrics."

NOTE: Only 3 of 9 letters to Advisory Committee and Industrial personnel have been answered.

Section 3

Part G

EVALUATION

There are two types of evaluation that are of concern to this project. The first deals with evaluating the quality and technical accuracy of the instructional materials that were developed. The second deals with the evaluation of the instructional materials by the users. This includes an evaluation by students who were involved in a two-week seminar and by all industrial teacher education departments and staff in the United States who received complete kits of these materials.

EVALUATION OF CONTENT FOR TECHNICAL ACCURACY

At the time that this project was funded in 1972, the only individuals who were qualified to check and evaluate the accuracy of the instructional material were those leaders from industry who had had broad and extensive experience in metric conversion. It was decided, therefore, that one of the main functions of the Advisory Board for the Center for Metric Education would be to help in the preparation of these instructional materials and also to evaluate them after they were completed.

At the first meeting of the Advisory Board on August 3 and 4, 1972, there was a thorough discussion of the instructional units to be developed and also of the techniques to be used. It was agreed at that board meeting that individuals on the Advisory Board best qualified to help would be personally responsible for reviewing at least one part of the kit. For example, Mr. Roy Trowbridge, Director of Engineering Standards, agreed to work with Eric Uitvlugt, who was a graduate assistant at Western Michigan University at that time, on the development of the kit on drafting. Mr. Ken Y. Taylor, President of Regal-Beloit, Inc., agreed to help in the development of the material on metalworking. Dr. Jack Simich, Education Director of the Graphic Arts Technical Foundation, agreed to help in the evaluation of the graphic arts material.

During the period of August 1972 until the third meeting of the Advisory Board on August 15, 1973, many individuals on the Advisory Board helped in reviewing the instructional material on an informal basis.

At the October 1973 meeting the morning was devoted to critiquing the individual units that were prepared. As shown in the Agenda, the following individuals presented material in the kits.

1. GOING METRIC FOR CAREER EDUCATION - John Lindbeck
2. GOING METRIC FOR STUDENTS - John Lindbeck
3. GOING METRIC IN DRAFTING - Michael Atkins
4. GOING METRIC IN WOODWORKING AND BUILDING CONSTRUCTION - John Lindbeck
5. GOING METRIC IN METALWORKING - John Feirer
6. GOING METRIC IN GRAPHIC ARTS - James Ulmer

It was at this meeting that suggestions were made for corrections and for improving the material. This was a most essential evaluation in the development of any instructional material.

EVALUATION OF USE

As part of the extension of this project, it was agreed that evaluation would be made to determine the usefulness of the materials in converting industrial education to metrics.

As part of the seminar held at Colorado State University, pre and post tests were given to determine what improvements in knowledge and understanding in metrics there were as part of this seminar. Much of the instructional material used in the seminar was based on the kits. Each member of the seminar was also responsible for evaluating three of the kits. Based on this information, an evaluation form was developed for use in surveying all of the departments in the United States that have obtained these kits of materials.

Following the seminar, on Friday, July 19, a conference was held with Dr. Daniel Stufflebeam, who is Head of the Center for Evaluation at Western Michigan University, to review the evaluation form for the seven packets of instructional material. The evaluation form was reviewed step by step and additions and suggestions were made by Dr. Stufflebeam. A preliminary evaluation form was also reviewed by the Project Monitor. Based on this conference and the suggestions from the U.S. Office of Education, a revised evaluation form, as shown in Figure 3G-1, was prepared for the total packet. An evaluation form for each

individual kit was also developed. Figure 3G-2. A cover letter was also prepared to include with the evaluation forms. Fig. 3G-3.

A SURVEY OF DEPARTMENTS USING GOING METRIC IN INDUSTRIAL EDUCATION

A survey of the industrial education departments using the GOING METRIC IN INDUSTRIAL EDUCATION packets is reported in this section under the headings of (1) Purpose of the Survey, (2) Procedures Followed, (3) Results of the Survey, and (4) Summary of Results.*

Purposes of the Survey

To help evaluate the Going Metric packets a survey was made of the one hundred eighty six industrial education departments using them. Two evaluation instruments were developed. The instrument, Evaluation of the Seven Packets of Instructional Materials Entitled: Going Metric in Industrial Education, was distributed to those industrial teacher education institutions in the United States that currently had a set of this material for their responses. The purposes were to determine:

1. how broadly the departments have disseminated the Going Metric packets to other users;
2. how extensively the departments are using the Going Metric packets in their instruction;
3. how many of the suggested metric tools and metric conversion materials the departments have purchased;
4. what other metric instructional or informational materials the departments want;
5. what new metric activities the departments have initiated since receiving the Going Metric packets; and
6. what other comments they want to make about the kits.

The other instrument, Evaluation of Metric Kits, was distributed to the instructors responsible for instruction relating to one of the seven kits in the Going Metric materials. The purposes were to determine for each kit:

1. how practical the kits are for their classes;

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*D. William Quinn, Evaluation Center
Western Michigan University

2. what the instructors think are the outstanding, helpful and unique features of the kits;
3. what the instructors think are the shortcomings, or what might be added to improve the kits;
4. what evidence do the instructors have to indicate the effectiveness of the kits.

Procedures Followed

The cover letter, one copy of Evaluation of the Seven Packets of Instructional Material Entitled: Going Metric in Industrial Education and seven copies of Evaluation of Metric Kits (one for each kit) were mailed to the participating departments* on October 15, 1975. On November 14, a second set of the above was mailed to all departments that had not yet responded to the first mailing. On November 24, a personalized letter was sent to non-responding departments to encourage them to respond. Figure 3G-4. December 18, 1975, was set as the cut-off date for inclusion of responses in this survey. Only evaluation instruments returned by that date are reported.

Both instruments were tabulated by hand. For open-ended questions (Evaluation of the Seven Packets of Instructional Material, question fourteen; Evaluation of Metric Kits, questions four, five, six, seven, eight, nine and ten) the following procedures were used.
1. Two individuals read the responses and separately developed categories for tabulating responses.
2. They compared the two lists of categories, resolving any diagreements, to produce a final set of categories.
3. They then independently scored the responses according to the final set of categories.
4. They compared the two scorings of the responses, resolving any disagreements, to produce a final categorization of responses.

Results of the Survey

Of the 186 departments surveyed, 109 (58.6%) returned usable survey forms. All departments that responded returned the Evaluation of the Seven Packets of Instruc-

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*Schools in the United States that prepare industrial education students received kits of these materials provided they attended one of the regional seminars. A few schools that could not attend the seminar were given the material as a final effort to complete dissemination.

tional Material instrument, but only 83 (45.2%) departments returned one or more usable forms of the Evaluation of Metric Kits. A total of 224 (17.2%) of the possible 1302 Evaluation of Metric Kits forms were returned (186 departments at 7 each equals 1302 forms).

Results of the Evaluation of the Seven Packets of Instructional Material Entitled: Going Metric in Industrial Education

Six areas of interest were identified for this instrument under Purposes of the Survey. The findings related to each of these areas are presented below. A summary of these findings appears at the end of this section. Unless otherwise notes, percentages are based on the total 109 respondents to the survey.

Duplication and Dissemination of the Packets

Of the responding departments, 64 (58.7%) had duplicated at least some of the kits and 45 (41.3%) had not. More kits were duplicated for departmental or local use than for regional or state-wide use. Most often a department made only one copy of the kits. About one-third (36%) of the departments duplicating kits made three or fewer copies. However, there was great variability in the number of copies made with about half (52%) duplicating kits making 10 or more copies of each kit. The bulk of the duplication was done by only a few departments. One department made 2,000 copies, accounting for 48% of all duplication. The three largest duplicators accounted for 74% of all copies made. Table A shows the frequency of duplicating kits for the various categories as well as the total number of kits duplicated for each category.

Each of the kits appeared to have been duplicated about as frequently as the others with one exception. The packet, COURSE OUTLINE AND TOOL KITS, was duplicated somewhat less frequently than the other packets.

The funds for duplicating kits came primarily from local departments with 39 (60.9%) of the duplicating departments listing this as a funding source. The three departments duplicating the most copies all reported non-departmental funds as a funding source. Table B shows how frequently different sources were cited for funding. Because several departments cited more than one funding source, the frequencies in Table B sum to more than 100% of the departments duplicating kits.

Transparencies were made from the masters in the

kits by 74 (67.9%) of the departments; 29 (26.6%) did not make transparencies and 6 (5.5%) did not say whether they had or not. Most often only one set of transparencies were made by a department, however, 16 (14.8%) departments made more than 6 sets and one department reported making 5,000. (It is not clear if they were referring to sets or individual transparencies, although the latter seems more likely.) Also, 13 (11.9%) departments did make transparencies but did not say how many they made.

Departmental Use of the Packets

Of the respondents, 93 (85.3%) are presently using the materials, 14 (12.8%) are not and 2 (1.8%) did not respond. The tendency was to use the materials more in preservice classes (85 or 78%) than in inservice classes (65 or 59.6%). In preservice classes the materials were more often used in regularly scheduled classes (64 or 58.7%) than in special metric classes (22 or 20.2%). However, with inservice classes the latter was reversed and the materials were more often used in special metric classes (39 or 35.8%) than in regularly scheduled classes (26 or 23.9%). Two of the respondents using the material did not specify in what classes they were using them.

When asked if the department had included the materials in its industrial education program of studies, 86 (78.9%) of the departments had, 21 (19.3%) hadn't and 2 (1.8%) did not respond. When asked if other related departments were including the Going Metric materials in their instruction, 43 (39.4%) said yes, 44 (40.4%) said no and 22 (20.2%) did not respond. (Comments written by respondents in the margin around the questionnaire indicated that in many schools there were no "related departments" at their university. This accounts in part for the large number of "no" answers and non-responses.)

The materials are being used in a number of courses of study with drafting being the most frequently mentioned one. Table C lists how many departments are using the material in different courses of study, the number of students enrolled and the percent of time. In addition to the five courses listed on the evaluation instrument, there were twenty four other courses listed as using the metric materials.

Purchases for Metric Conversion

The Going Metric materials suggest the purchase of different tools and conversion kits in conjunction with instruction in metrics. Of the departments that responded, 49 (45%) had purchased hand tools described in the packets, 58 (53.2%) had not and 2 (1.8%) did not respond. The

following is a breakdown of the hand tools purchased and the number of departments which purchased them:

Measuring tools in metalworking (including scales, micrometers, verniers, etc.)	42	(38.5%)
Scales and templates for drafting	37	(33.9%)
Measuring tools for woodworking	24	(22%)
Not specified	1	(0.9%)

Two departments indicated that they had constructed wood kit boxes to hold the above tools and that department funds were used.

When asked if any of their metalworking machines had been converted for dual reading as a result of use of the metric kit materials, 11 (10.1%) said yes, 96 (88.1%) said no and 2 (1.8%) did not respond. Of those who said "yes", 9 said dual readout dials were installed and 2 said digital readout units were used. The funds to make the changes came from departments (8 departments said this), from the state (1 department said this) or were unspecified (2 did not specify where funds came from).

Other Metric Materials Wanted

When asked what other items they would find useful, respondents checked the items as follows:

Newsletter with up-to-date information on metrics	75	(68.8%)
Filmstrips or slides	67	(61.5%)
Catalog of metric equipment and supplies	56	(51.4%)
Programmed learning texts	55	(50.5%)
More detailed course of study	49	(45%)
Technical metric units	45	(41.3%)
More references	35	(32.1%)
[1]Texts with all math, etc., in metrics	2	(1.8%)
[1]A consumer education general type of program	1	(0.9%)
No response	5	(4.6%)

When asked if they would be interested in receiving a new kit entitled GOING METRIC IN HOME ECONOMICS, 89 (81.7%) said yes, 14 (12.8%) said no, and 6 (5.5%) did not respond. Several indicated that they were particularly interested in the consumer education aspect of such a kit.

Metric Activities Initiated Since Receiving Packet

Most of the departments had initiated some type of metric activity since receiving the Going Metric packets. The most frequently checked activity was including metric activites in each technical area; the least frequently

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[1]This item was added on the list by one or more of the respondents.

checked was having a metric committee. Table D lists the frequency of responses to the question of what activities had been initiated since receiving the kits.

Comments About the Kits

The final item asked for any comments about the kits that the respondent wished to make. Most of the respondents (71 or 65.1%) made one or more comments about the kits while 38 (34.9%) did not. More than twice as many positive comments were made than negative comments or neutral comments. (of the total comments, 56.8% were judged to be positive, 22% were judged to be negative and 21.2% were judged to be neutral regarding the worth of the kits.) The following are the categories of positive comments and the frequency.[2]

Overall quality of kits was excellent or good	32 (29.4%)
Kits were helpful or useful	17 (15.6%)
Kits helped us get started in metrics	10 (9.2%)
Information presented in kits was good	6 (5.5%)
We are using the materials a lot	4 (3.7%)
Kits are suitable for an introductory course in metrics	3 (2.8%)
Quality of transparency masters good	3 (2.8%)

The following are the categories of negative comments and the frequency that they were given:

We are not using the materials very much	14 (12.8%)
Some information in the kits needs improvement or the kits are not appropriate for the college level	7 (6.4%)
Faculty members are not interested in the kits	3 (2.8%)
We already have similar metric materials	3 (2.8%)
Cross index transparencies between kits	1 (0.9%)
Make some transparencies more legible	1 (0.9%)

The following are the categories of neutral comments and the frequency that they were given:

Have or will share kits with other institutions	11 (10.1%)
Kits are or would be good for elementary and/or secondary level	7 (6.4%)

[2]Because many respondents made more than one type of comment, these frequencies sum to more than the total number of respondents.

Limited funds prevented us from duplicating and using the kits as we wanted to. 5 (4.6%)

We would like kits on other topics or additional materials and help (posters, workshops, slides). 3 (2.8%)

We would like a policy statement on duplication of kits. 2 (1.8%)

We can't give feedback on kits until we have used them longer 2 (1.8%)

RESULTS OF THE EVALUATION OF METRIC KITS

Four areas of interest were identified for this instrument under PURPOSES OF THE SURVEY. The findings related to each of these areas are presented below. Also, general critiques made of the kits are summarized below. Findings which apply generally across kits will be discussed as well as findings which are specific to particular kits. A summary of these findings appears at the end of this section.

Because of the unequal number of surveys returned per kit, findings are usually given as percentages rather than simple tally counts to aid comparison of responses across kits. Percentages are based on the total number of respondents for the particular kit under consideration. The number of respondents per kit are:

Career Education	30
Students	20
Drafting	46
Graphic Arts	23
Metalworking	37
Woodworking/ Construction	30
Course Outline	16
Multiple Kits or Kits Unspecified	22

The last category listed above was the result of labeling: the instrument either was titled "all kits," or a combination of kits, or they were untitled. For the purpose of clarification, they were put into a separate category.

Practicality for Classes

Most of the raters felt the kits were practical for the class situation. Summing the two categories of Yes and Yes Partially, the responses ranged from 100% falling

in the above two categories for Metalworking to 81% for the Course Outline. Table E lists the distribution of responses regarding practicality of use.

Outstanding, Helpful, or Unique Features

Two questions addressed this aspect of the kits. The first question asked was, "What are the outstanding features of the materials?" The four most frequently given responses were (1) kits were simple, clear, easy to understand; (2) transparency masters are good and/or helpful; (3) good coverage of content; (4) easy for teachers to use. However, for three of the kits the most frequently given responses were not included in the above categories. For the Student kit, the programmed instruction was most often cited as being outstanding (25%). For the Graphic Arts kit, the conversion charts and tables were most often given (30%). And, for the Woodworking and Construction kit, both the conversion charts and tables, and the specific information on industry and/or the profession were as often listed as outstanding features (17%). Table F lists all of the responses across each of the kits for this question.

The second question concerned with positive aspects of the kits was, "Are any masters especially helpful or unique? Why?" Only a small percentage of the raters said no (responses ranged from zero percent to 20% for different kits). Many that said no did so because they felt the masters were of equal worth rather than of no worth at all.

The four most commonly given features or reasons for citing masters as being helpful or unique were (1) specific information on industry and/or professional practice; (2) conversion charts, tables, etc., (3) examples, plans, drawings, etc.; and (4) the general introduction and/or coverage of metrics presented in the masters. Table G lists all of the responses given for the different kits.

Shortcomings or Additions

Two questions covered this aspect of the kit. The first question was, "What could have made the material more useful to you?" The most frequently given response across the kits was that everything was okay, or that they could not think of anything. The four most frequently mentioned shortcomings or charges were, (1) more projects, activities, workbooks, etc.; (2) more detailed notes and comments, (3) improve some particular aspect of the transparencies; and (4) greater depth and sophistication in the materials. For two kits the most often shortcomings or

charges were not included in the above categories. For the Metalworking kit the most frequently listed comment was to add more information (tables, charts, etc.) on converting from customary to metric measures (17%). For the Course Outline raters asked for aids to instruction as frequently as for greater depth and sophistication in materials (13% each). Table H lists all of the comments for the different kits on this question.

The second question for this area asked, "What additional materials would you like to see in the kits?" As with the first question on shortcomings, the most commonly given response was that everything was okay or that they could not think of anything. The four most frequently mentioned additions suggested were, (1) more conversion information; (2) more information on industry and/or professional use of metrics; (3) more projects, activities, workbooks, etc.; and (4) additional visuals to supplement the masters. For two kits the most commonly given responses were not included in the above categories. For the Graphic Arts kit the more frequently given response was to add sources and references for information on metrics (22%). For the Course Outline, aids to instruction were requested most often (25%). Table I lists the wanted additions for the different kits.

Evidence of Effectiveness

When asked if they had statistical data to indicate the effectiveness of the kit, only 2 of the 224 respondents said yes, 216 said no, and 12 did not reply. One of the two marking yes wrote, "Pre-test, post-test scores indicating the kit material to be a good teaching tool." The other commented, "Material was used in class of twenty students; 80% of students' progress were satisfying.

Two others who marked no made the following comments: "[No] but students have done well on assigned drawings and measuring activities" and, "Only class interest and improvement with materials are reported by committee development."

General Comments About Kits

After raters responded to questions in the above four areas, they were asked to give a general critique of the kits. The two (materials were helpful and/or effective and materials were of high quality) are positive comments about the kits. The next two most frequently given comments (specific problems cited with material; and greater depth and sophistication needed in material) are negative comments about the kits. Although two of the four most

commonly given comments were negative, only one of the kits had a negative comment as being the most frequently given comment. For the Graphic Arts kit, raters said the materials needed greater depth and sophistication as often as they said the materials were helpful and/or effective (17% each). Table J lists the responses made in critiquing the kits.

SUMMARY OF RESULTS

The results presented in this section may be summarized in eleven statements. The first six come from the main evaluation instrument, the next five come from the Evaluation of Metric Kits form.

1. More than half of the departments duplicated at least some of the kits for their own use. A few of the departments duplicated and disseminated the kits very extensively throughout their states.
2. Most of the departments are using the kits in preservice and/or inservice classes. Also, they are using the kits in courses that cover a wide variety of topics.
3. Slightly less than half of the departments have purchased at least some of the metric hand tools suggested in the kits, but most have not converted their metalworking tools to dual reading.
4. Respondents were interested in receiving other metric materials. The most frequently requested item was a newsletter on current metric activities and information.
5. Most of the departments have initiated some type of metric activity since receiving the kits. Most commonly this activity was the inclusion of metric instruction in each of the technical areas.
6. When asked to make overall comments about the kits, more than twice as many positive comments were made as were negative ones. The most commonly given positive comment was that the overall quality of kits was excellent or good. The most commonly given negative statement was that they were not using the metric kits very much.
7. Most of the users of the kits rated them as being practical for classroom use.
8. The outstanding identified feature of the materials is their simplicity, clarity, and ease of understanding. The most helpful or unique transparencies presented specific information on metric use, conversion from customary to metric, or examples illustrating metric applications.
9. The most frequently mentioned shortcoming of the kits was the need for more projects, activities, workbooks, etc. The most frequently mentioned additional material

needed for the kits was more conversion information such as tables, charts, etc. However, about one in eight said that there were no shortcomings or needed additions to the kits.

10. Only two of the two hundred twenty four respondents reported gathering statistical data to indicate the effectiveness of the kits. The two said their data indicated that the kits performed well.

11. When making a general critique of the specific kits, positive comments were made more frequently than negative ones. The most frequently given positive comments were that the materials were helpful and/or effective and that the materials were of high quality. The most frequent negative comments involved specific problems cited regarding the materials and a need for greater depth and sophistication in the materials

FOLLOW UP

As each evaluation instrument was returned to the Center, a form letter was sent to the Head of the Industrial Education Department with a copy to the Head of the Home Economics Department at that school indicating that the kit, GOING METRIC IN HOME ECONOMICS, was being sent to that institution. Figure 3G-5. A complete list of all the schools who have received these kits, GOING METRIC IN INDUSTRIAL EDUCATION and GOING METRIC IN HOME ECONOMICS, are listed in Appendix A.

Also, as a part of the follow up, it was agreed to provide each school who had participated with a supplementary kit of materials. A list of the items included in the supplementary kit is shown in Figure 3G-3. The supplementary kit was mailed to all schools to update some of the material that appeared in the original kit and to provide some additional useful teaching materials.

Figure 3G-1

EVALUATION OF THE SEVEN PACKETS OF INSTRUCTIONAL MATERIAL ENTITLED:

GOING METRIC IN INDUSTRIAL EDUCATION

Center for Metric Education
Western Michigan University
Kalamazoo, Michigan 49008

1. Name of Institution: _____

2. Name of the Individual Filling Out this Report:

_____

3. Have you duplicated these kits? _____ Yes _____ No

If yes, check distribution and number of copies.

	For departmental use	For local use	For regional use	For state-wide use	Number of copies
1. Going Metric in Career Education					
2. Going Metric for Students					
3. Going Metric in Graphic Arts					
4. Going Metric in Woodworking and Building Construction					
5. Going Metric in Metalworking					
6. Going Metric in Drafting					
7. Course Outline and Tool Kits					

What type of funds were used? _____

4. Were transparencies made from the masters? _____ Yes _____ No

If yes, how many copies? _____

5. Are you presently using this material? _____ Yes _____ No

If yes, in what class? _____ A. Preservice

_____ 1. Part of regularly scheduled

_____ 2. Special Metric

_____ B. Inservice

_____ 1. Part of regularly scheduled

_____ 2. Special Metric

6. After receipt of Center for Metric Education materials, did your school department or division include them in metric instruction in its Industrial Education program of studies? _____ Yes _____ No

Did other related departments (if I.A., T & I or technical departments separate) include them in their instructional programs? _____ Yes _____ No

If yes, in what courses of study? Check as many as apply.

				Percent of Time
A. Drafting	_____	No. enrolled	_____	_____%
B. Machine Shop	_____	No. enrolled	_____	_____%
C. General Metals	_____	No. enrolled	_____	_____%
D. Woodworking/ Construction	_____	No. enrolled	_____	_____%
E. Graphic Arts	_____	No. enrolled	_____	_____%
F. Other, Specify _____	_____	No. enrolled	_____	_____%

7. Have the hand tools described in the packet of instructional material been purchased? _____ Yes _____ No

If yes, check those that apply.

A. Measuring tools in metalworking including scales, mics, verniers, etc. _____
B. Scales and templates for drafting _____
C. Measuring tools for woodworking _____

8. Have wood kit boxes been constructed to hold the metric measuring tools? _____ Yes _____ No

If yes, what type of funds were used? _____

9. Have any of your metalworking machines been converted for dual reading as a result of use of metric kit materials? _____ Yes _____ No

If yes, check those that apply.

A. Dual reading dials _____ How many? _____
B. Digital readout units _____ How many? _____

What type of funds were used? _____

10. In addition to the materials included in the Going Metric Packets, what other items would you find useful? Check those that apply.

A. More detailed course of study _____
B. More references _____
C. Catalog of metric equipment and supplies _____
D. Filmstrips or slides _____
E. Programmed learning texts _____
F. Technical metric units _____
G. Newsletter with up-to-date information on metrics _____

11. Has your department increased its involvement in metric activities since receiving the Going Metric Packet?

    A. Have a metric committee? _____ Yes _____ No
    B. Offer inservice courses in metrics? _____ Yes _____ No
    C. Offer seminars or workshops in metrics? _____ Yes _____ No
    D. Include metric activities in each technical area? _____ Yes _____ No

12. Enclosed are 7 copies of an evaluation form for the Going Metric kits. Will you have the professor in charge of the appropriate course fill one out for that course and return them with this survey?

    A. Going Metric in Drafting? _____ Yes _____ No
    B. Going Metric in Metalworking? _____ Yes _____ No
    C. Going Metric in Woodworking and Building Construction? _____ Yes _____ No
    D. Going Metric in Graphic Arts? _____ Yes _____ No
    E. Going Metric for Career Teachers? _____ Yes _____ No
    F. Going Metric for Students? _____ Yes _____ No
    G. Course of Study and Tool Kits? _____ Yes _____ No

13. Are you interested in receiving a kit entitled, GOING METRIC IN HOME ECONOMICS AND CONSUMER EDUCATION? _____ Yes _____ No

    If yes, will you share it with your home economics department? _____ Yes _____ No

    Please give us the name of the chairman of your home economics department. _____

14. Comments about the Kits. _____

    _____

    _____

    _____

    _____

    _____

The personnel at the Center for Metric Education, Western Michigan University, wish to thank you and your colleagues for completing these evaluation forms.

Center for Metric Education, Western Michigan University
Kalamazoo, Michigan 49008, Telephone: 616-383-1879

Figure 3G-2

EVALUATION OF METRIC KITS

Institution _____

Name of Instructor _____

Name of Kit _____

Is the material practical for your class situation? _____

What are the outstanding features of the material? _____

_____

_____

Are any masters especially helpful or unique? Why? _____

_____

_____

What could have made the material more useful to you? _____

_____

_____

What additional material would you like to see in the kits? _____

_____

_____

_____

Do you have any statistical data that would indicate the effectiveness of these kits? _____ Yes _____ No

If yes, please indicate. _____

_____

_____

General Critique (150 words - use reverse side of sheet)

Figure 3G-3

CENTER FOR METRIC EDUCATION

WESTERN MICHIGAN UNIVERSITY
KALAMAZOO, MICHIGAN 49008

Dear Fellow Teacher Educator:

By the time you read this letter it is entirely possible that the Metric Conversion Act of 1975 has been passed by Congress and signed into law by President Ford. It is has not happened, you can be assured that this event will take place sometime during the school year of 1975-1976.

Since industrial education derives its content from industry and since most of the large U.S. industries have made a firm commitment to go metric, it is our responsibility to adapt teacher education programs to include metric measurement.

Your institution has received a complete set of the kit entitled, GOING METRIC IN INDUSTRIAL EDUCATION. The attached evaluation form is an attempt to determine what uses have been made of these materials, and what plans you have for "going metric". We would appreciate your filling out the evaluation form for the total kit. Please ask the individual in charge of the technical areas to evaluate the specific kit for these areas.

We have prepared an excellent new kit entitled, GOING METRIC IN HOME ECONOMICS, which would be useful in that area and also for consumer education. All institutions returning these forms will receive a copy of this material plus an update of the changes that have taken place in ISO standards, particularly paper and thread standards.

We realize that this is a busy time for you, however, since our project terminates January 1, 1976, we need this information now to complete our study.

Your cooperation will be greatly appreciated. Certainly a good response will indicate to the U.S. Office of Education that more funds should be spent for metric conversion.

We look forward to hearing from you.

Sincerely,

John L. Feirer, Director
Center for Metric Education

Enclosures

Figure 3G-4

TO

FROM
John L. Feirer, Director
Center for Metric Education
Western Michigan University
Kalamazoo, Michigan 49008

SUBJECT GOING METRIC IN INDUSTRIAL EDUCATION DATE 11/25/75

Won't you help us evaluate the packets that were sent to you entitled GOING METRIC IN INDUSTRIAL EDUCATION? We are most anxious to include your school in our evaluation returns.

The packet of material for your institution was signed for by _____ on _____.

SIGNED John L. Feirer

REPLY

DATE / /

SEND PARTS 1 AND 3 WITH CARBON INTACT. - PART 3 WILL BE RETURNED WITH REPLY.

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Figure 3G-5

CENTER FOR METRIC EDUCATION
WESTERN MICHIGAN UNIVERSITY
KALAMAZOO, MICHIGAN 49008

Thanks for participating in our evaluation of the seven packets of instructional materials entitled, GOING METRIC IN INDUSTRIAL EDUCATION. We hope that you will make good use of all of our materials. Remember, you are free to reproduce any of the materials in any quantity.

Attached is a set of the materials entitled, GOING METRIC IN HOME ECONOMICS, we promised you. These transparency masters and notes should be of particular interest to faculty members in your Home Economics Department. Won't you share these materials with other faculty members on your campus?

Sincerely,

John L. Feirer, Director
Center for Metric Education

jr

Attachment: GOING METRIC IN HOME ECONOMICS

CC:

Figure 3G-6

GOING METRIC IN INDUSTRIAL EDUCATION

SUPPLEMENTARY KIT

1. General
   - A. Large four-color wall chart--MODERNIZED METRIC SYSTEM
   - B. Bibliography
   - C. Guide for tools and materials
   - D. Other Charts
2. Metalwork
   - A. Conversion chart for metalwork
   - B. Chart for metric metal sizes
   - C. Preferred ISO threads
   - D. Conversion table
   - E. Transparency for direct reading micrometer
   - F. 300 mm rule for metalwork--plastic
   - G. Sample projects
3. Woodwork
   - A. Conversion table for woodworking
   - B. 300 mm rule for woodwork--plastic
   - C. Sample projects
4. Drafting
   - A. Paper standards chart
   - B. 300 mm drafting scale--plastic
   - C. Drafting exercises

TABLE A

DUPLICATION AND DISTRIBUTION OF GOING METRIC KITS

NAME OF KIT	Frequency Checking Various Levels of Use of Kits				Number of Copies Across Levels of Use	Level of Use Not Specified	No. of Copies Not Given	No Response
	Departmental	Local	Regional	State-wide				
Going Metric in Career Education	41	23	15	17	4,733	1	7	10
Going Metric for Students	42	24	15	17	4,467	1	10	10
Going Metric in Graphic Arts	36	18	17	17	3,995	1	8	12
Going Metric in Woodworking and Building Construction	40	18	17	17	4,114	1	9	12
Going Metric in Metalworking	44	19	16	17	4,349	1	10	7
Going Metric in Drafting	41	21	14	16	4,165	1	10	9
Course Outline and Tool Kits	31	17	13	16	3,985	1	7	22

TABLE B

TYPES OF FUNDS USED TO DUPLICATE KITS

Type of Funds Used	Frequency
Departmental	39
State	8
Public School District	4
Student	3
Regional	1
Personal	1
Other*	7

*Included in "other" are the following: A. B. Dick Co. grant, Conn. Industrial Arts Assoc. grant, Department of Corrections, "EPDA", Learning Resource Center, Main School Management Assoc. and Secondary Prin. Assoc.

TABLE C

USE OF GOING METRIC KITS IN VARIOUS COURSES OF STUDY, NUMBER OF STUDENTS ENROLLED AND PERCENT OF TIME

Course of Study	Frequency Checked	NUMBER ENROLLED[1]			PERCENT OF TIME		
		Median	Lower/Upper Bound	No. Not Given	Median %	Lower/Upper Bound %	% Not Given
Drafting	44	100	25 - 350	13	10	2 - 100	19
Machine Shop	38	40	13 - 300	11	5	2 - 100	18
General Metals	31	50	14 - 200	10	5	2 - 100	18
Woodworking/ Construction	29	56	10 - 110	7	5	1 - 15	15
Graphic Arts	22	55	10 - 200	6	5	1 - 25	12
Other[2]	25	25	20 - 200	11	10	2 - 100	14

[1] Some reported enrollment for a semester or term, others reported total yearly enrollment.

[2] Courses included under "other" are: photography, auto shop, general shop, electrical, navy reserve, nursing administration, power mechanics, metrics workshops, vocational education math, elementary education class, math, methods class and seminar, State Department of Education seminar.

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TABLE D

INCREASED DEPARTMENTAL INVOLVEMENT IN METRIC ACTIVITIES SINCE RECEIVING GOING METRIC PACKET

Area of Activity	Yes	No	No Response
Include metric activities in each technical area?	70 (64.2%)	28 (25.7%)	11 (10.1%)
Offer seminars or workshops in metrics?	49 (45%)	42 (38.5%)	18 (16.5%)
Offer inservice courses in metrics?	40 (36.7%)	50 (45.9%)	19 (17.4%)
Have a metric committee?	22 (20.2%)	75 (68.8%)	12 (11%)

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TABLE E

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"IS THE MATERIAL PRECTICAL FOR YOUR CLASS SITUATION?"

Going Metric Kits		Categories of Responses			
		Yes	Yes, Partially	No	No Response
Going Metric in Career Education	(30)[1]	77[2]	10	13	0
Going Metric for Students	(20)	80	10	0	10
Going Metric in Graphic Arts	(23)	70	9	17	4
Going Metric in Woodworking and Building Construction	(30)	67	17	10	7
Going Metric in Metalworking	(37)	73	27	0	0
Going Metric in Drafting	(46)	87	9	4	0
Course Outline and Tool Kits	(16)	81	0	6	13
Multiple Kit or Kit Unspecified	(22)	86	5	5	5

NOTE: Because of rounding error, some of the rows add to 101 percent.

[1]The total number of respondents for each kit.

[2]The percentage of responses per category based upon the total number of respondents for that kit.

TABLE F

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"WHAT ARE THE OUTSTANDING FEATURES OF THE MATERIAL?"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits Kits Unspecified (22)
Kit was simple, clear, easy to understand	23[2]	15	28	26	22	7	6	14
Transparency masters are good/helpful	10	15	28	17	16	13	6	23
Good coverage of content	27	10	17	4	14	13	13	18
Easy for teachers to use	10	10	7	0	14	7	31	23
Conversion information from customary to metric good	0	5	16	30	5	17	0	0
Specific information on industry/ profession	3	5	9	13	16	17	0	5
Examples in transparencies good	7	10	16	0	11	7	0	0
The way the materials are organized	0	0	4	9	8	3	6	14
Overall quality of kits good	3	0	4	0	8	3	13	0
Notes, comments, references good	3	5	9	0	5	3	0	5

NOTE: Because of multiple responses, columns may sum to greater than 100 percent.

[1]The total number of respondents for each kit.

[2]The percentage of responses per category based upon the total number of respondents for that kit.

TABLE F Continued

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"WHAT ARE THE OUTSTANDING FEATURES OF THE MATERIAL?"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits/ Kits Unspecified (22)
Problems, programmed instruction good	0	25	2	0	0	3	0	0
Aid with conversion of tools good	0	0	0	0	3	10	13	0
There was nothing outstanding	3	0	0	9	3	0	0	9
Material is interesting to students	0	5	0	0	3	0	0	0
Material would be appropriate for non-college students (jr. or high school)	3	0	2	0	0	0	0	0
No response	17	10	7	22	11	27	9	18

NOTE: Because of multiple responses, columns may sum to greater than 100 percent.

[1]The total number of respondents fpr each kit.

[2]The percentage of responses per category based upon the total number of respondents for that kit.

TABLE G

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"ARE ANY MASTERS ESPECIALLY HELPFUL OR UNIQUE? WHY?"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits/ Kits Unspecified (22)
Are any masters especially helpful or unique?								
Yes	17[2]	30	17	22	14	23	19	23
No (all are the same)	13	20	4	9	14	3	13	0
All are good	7	10	7	4	14	13	13	5
Some are good	10	0	2	0	5	0	0	0

NOTE: Because of some people responding to only one part of the question, percentages within columns for each sub-part of question do not sum to 100 percent.

[1]The total number of respondents for each kit.

[2]The percentage of responses per category based upon the total number of respondents for that kit.

TABLE G Continued

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"ARE ANY MASTERS ESPECIALLY HELPFUL OR UNIQUE? WHY?"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits/ Kits Unspecified (22)
	WHY?							
Specific information on industry or profession	3	0	17	48	11	30	0	5
Conversion charts, tables, etc.	10	5	22	9	8	3	0	9
Examples, plans, drawings, etc.	0	0	15	0	11	20	0	0
General introduction/coverage of metrics	20	5	4	4	0	3	0	9
Easy for teachers to use	3	5	7	0	8	3	6	9
Overall quality of kits good	7	5	2	4	5	3	6	5

NOTE: Because of some people responding to only one part of the question, percentages within columns for each sub-part of question do not sum to 100 percent.

[1]The total number of respondents for each kit.

[2]The percentages of responses per category based upon the total number of respondents for that kit.

TABLE G Continued

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"ARE ANY MASTERS ESPECIALLY HELPFUL OR UNIQUE? WHY?"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits. Kits Unspecified (22)
WHY?								
Materials were helpful/effective	3	0	7	4	3	7	0	9
Illustration of conversion of tools	0	0	0	0	14	13	0	0
Problems, exercises, projects	0	10	0	0	0	0	0	0
Programmed unit	3	5	0	0	0	0	0	0
No response (to any part of this question)	30	25	26	17	14	10	56	41

NOTE: Because of some people responding to only one part of the question, percentages within columns for each sub-part of question do not sum to 100 percent.

[1]The total number of respondents for each kit.

[2]The percentages of responses per category based upon the total number of respondents for that kit.

TABLE H

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"WHAT COULD HAVE MADE THE MATERIAL MORE USEFUL TO YOU?"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits/ Kits Unspecified (22)
Everything OK--can't think of anything	7[2]	35	13	13	19	13	6	0
More projects, activities, workbooks, etc.	7	20	9	4	11	13	6	9
More detailed notes and comments	10	0	20	22	14	3	0	5
Improve some aspects of transparencies--larger lettering, index no., grammar, etc.	13	5	17	9	5	0	6	5
Greater depth and sophistication in materials	13	10	7	0	0	3	13	14
Provide other visuals--slides, charts, etc.	3	15	2	13	5	0	6	5

NOTE: Because of some people responding to only one part of the question, percentages within columns for each sub-part of question do not sum to 100 percent.

[1]The total number of respondents for each kit.

[2]The percentage of responses per category based upon the total number of respondents for that kit.

TABLE H Continued

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"WHAT COULD HAVE MADE THE MATERIAL MORE USEFUL TO YOU?"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits/ Kits Unspecified (22)
Provide aids to instruction--seminars, suggestions for use, etc.	7	0	9	6	3	10	13	5
More information on industry/profession	7	0	9	9	5	3	0	0
More conversion information--charts, tables	0	5	0	0	5	17	0	0
Kits on more topics	3	0	2	4	3	0	6	5
Help in obtaining/converting to metric tools	3	0	0	4	0	7	6	0
Don't teach conversion--just teach metrics	3	0	4	4	0	3	0	0
Explain background, motivation for metric conversion	3	0	0	4	0	0	0	5
Give sources and references for information	0	0	2	0	0	0	0	9

NOTE: Because of some people responding to only one part of the question, percentages within columns for each sub-part of question do not sum to 100 percent.

[1]The total number of respondents for each kit.

[2]The percentage of responses per category based upon the total number of respondents for that kit.

TABLE H Continued

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"WHAT COULD HAVE MADE THE MATERIAL MORE USEFUL TO YOU?"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits/ Kits Unspecified (22)
More copies of the same kit	0	0	0	0	0	3	0	5
We would have liked getting the kits sooner	0	0	0	4	3	0	0	0
Condense the materials	3	0	0	0	0	0	0	0
Eliminate project plans	0	0	0	0	0	3	0	0
No response	30	10	17	22	27	27	38	36

NOTE: Because of some people responding to only one part of the question, percentages within columns for each sub-part of question do not sum to 100 percent.

[1]The total number of respondents for each kit.

[2]The percentage of responses per category based upon the total number of respondents for that kit.

TABLE I

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"WHAT ADDITIONAL MATERIAL WOULD YOU LIKE TO SEE IN THE KITS?"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits/ Kit Unspecified (22)
Everything OK--can't think of anything	13[2]	15	15	9	22	7	6	5
More conversion information--charts, tables	7	5	13	17	8	23	6	9
More information on industry/profession	20	15	9	9	14	3	13	0
More projects, activities, workbooks, etc.	10	10	13	0	8	7	6	18
Provide other visuals--slides, charts, etc.	7	5	2	9	8	3	6	9
Provide aids to instruction--seminars, suggestions for use, etc.	0	0	2	4	3	3	25	9
Kits on more topics	7	10	0	17	0	0	6	0

NOTE: Because of some people responding to only one part of the question, percentages within columns for each sub-part of question do not sum to 100 percent.

[1]The total number of respondents for each kit.

[2]The percentage of responses per category based upon the total number of respondents for that kit.

TABLE I Continued

PERCENTAGE OF RESPONSES BY KITS TO THE QUESTION
"WHAT ADDITIONAL MATERIAL WOULD YOU LIKE TO SEE IN THE KITS?"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits/ Kit Unspecified (22)
Help in obtaining/converting to metric tools	0	10	7	0	5	7	6	0
More detailed notes and comments	10	0	11	0	3	3	0	5
Give sources and references for information	3	0	2	22	0	0	0	0
Greater depth and sophistication in materials	3	5	0	0	5	7	0	5
Don't teach conversion--just teach metrics	3	10	2	0	3	0	0	0
Explain background/motivation for metric conversion	0	0	2	0	0	0	0	9
Improve some aspects of transparencies--sequence code number	3	0	0	0	0	0	0	0
No response	27	30	26	35	24	40	31	32

NOTE: Because of some people responding to only one part of the question, percentages within columns for each sub-part of question do not sum to 100 percent.

[1]The total number of respondents for each kit.

[2]The percentage of responses per category based upon the total number of respondents for that kit.

TABLE J

PERCENTAGE FREQUENCY DISTRIBUTION OF RESPONSES BY KITS TO THE ITEM, "GENERAL CRITIQUE (OF KIT)"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits/ Kits Unspecified (22)
Materials were helpful/effective	17[2]	20	17	17	22	17	19	41
Materials were of high quality	20	15	30	13	16	10	25	18
Specific problems cited with material	17	10	9	13	8	10	19	9
Greater depth and sophistication needed in materials	17	5	9	17	0	7	6	0
Complimentary comments--thanks, keep up the good work, etc.	0	15	7	9	11	0	13	5
Materials are a good beginning foundation	7	5	7	9	0	10	0	9
Kits needed on more topics	7	5	0	0	5	10	13	0
Teach metrics before teaching conversion	7	5	7	4	3	7	0	0
More projects, activities, workbooks, etc.	7	5	2	0	3	3	6	5

NOTE: Because of some people responding to only one part of the question, percentages within columns for each sub-part of question do not sum to 100 percent.

[1]The total number of respondents for each kit.

[2]The percentage of responses per category based upon the total number of respondents for that kit.

TABLE J Continued

PERCENTAGE FREQUENCY DISTRIBUTION OF RESPONSES BY KITS TO THE ITEM, "GENERAL CRITIQUE (OF KIT)"

Category of Comments	GOING METRIC KITS							
	Career Education (30)[1]	Students (20)	Drafting (46)	Graphic Arts (23)	Metalworking (37)	Woodworking/ Construction (30)	Course Outline (16)	Multiple Kits/ Kits Unspecified (22)
We are just beginning metric instruction	0	5	2	0	3	3	6	5
This kit is not needed	3	5	2	4	0	0	6	0
More information on industry/profession	3	0	0	9	0	7	0	0
Give sources and references for information	3	0	2	0	3	3	0	5
Provide instructional aids and instruments in other forms	0	0	4	0	0	0	6	0
Securing metric tools has been a problem	0	0	0	0	3	3	0	5
Materials should be widely distributed	0	5	2	0	0	0	0	0
No response	40	35	39	39	49	50	25	36

NOTE: Because of some people responding to only one part of the question, percentages within columns for each sub-part of question do not sum to 100 percent.

[1] The total number of respondents for each kit.

[2] The percentage of responses per category based upon the total number of respondents for that kit.

Section 3

Part H

OTHER ACTIVITIES

In addition to the specific goals outlined in the proposal submitted for approval, the Center for Metric Education became involved in a number of other activities closely related to but not directly a part of the original project proposal. These included the following:

1. Development of a kit entitled GOING METRIC IN HOME ECONOMICS - At the request of the then monitor of this federal project, Dr. Elizabeth Simpson of the U.S.O.E., the Directors agreed to develop a set of instructional materials in the field of home economics and consumer education. This project was developed in much the same way as the other kits entitled GOING METRIC IN INDUSTRIAL EDUCATION.

A home economics consultant, Mrs. Laurabelle Roderick, was hired to develop and produce the GOING METRIC IN HOME ECONOMICS materials. Mrs. Roderick is a qualified home economist and is a faculty member in the Home Economics Department at Western Michigan University. In cooperation with the Directors of the project, it was decided to produce a kit of transparency masters with notes in the areas of foods and clothing.

As a first step Mrs. Roderick reviewed all of the material on metrics in home economics that was in the Center for Metric Education library, particularly from England, Australia and New Zealand. Each of these three countries have developed extensive materials in the field of home economics. The consultant also contacted home economists in Canada, England, Sweden and several other countries concerning their metric programs.

After a thorough review of all the material available, Mrs. Roderick developed an outline of the units to be included and the transparency masters to be produced. These were reviewed and checked for accuracy by the staff of the Home Economics Department in the areas of foods, clothing and textiles. The art work was then given to an artist to be completed and the transparency masters were reproduced. Two hundred packets of transparency masters and the accompanying notes were developed.

After the material was completed, there was a discussion concerning the best method of disseminating the packets to other teacher education institutions throughout the United States. It was finally decided to incorportate dissemination with the evaluation procedure used for the first seven packets of material entitled GOING METRIC IN INDUSTRIAL EDUCATION. In the letter of transmittal sent with the evaluation form a paragraph indicated that those schools returning the evaluation form would be sent a set of the home economics materials. As each evaluation form was received, a letter of appreciation was sent to the individual completing the evaluation form indicating that a copy of the material was being sent. At the same time a letter was sent to the home economics department chairman at that school indicating that this set of materials was on their campus for their use. Approximately one hundred kits of these materials were distributed to colleges in the United States.

2. Resource Center - One of the first steps in developing this project was to establish a library and resource center. During the first two years of this project this resource center represented one of the best and most complete libraries for metric materials in the United States. As a result, there were numerous requests to use these materials. The resource center served a variety of departments within the University, school districts throughout the area, various industries interested in metric conversion and a substantial number of schools and industries throughout the United States.

Visitors to the Center came from as far as Florida, New England, Texas, Colorado and Hawaii. The resources of the Center were also used for various inservice seminars throughout the State of Michigan. A great deal of the material from the Center was used for the State-sponsored metric project at the Wayne-Westland School District.

3. Video Tape on Metric Conversion - As part of the Advisory Board meeting on December 1, 1972, a one-hour video tape concerning metric conversion was produced utilizing the expertise of the various members of this advisory committee. See Section 3, Part C. Two copies of this video tape were made, one in the one-inch size and another in the half-inch size. From 1972 through 1975 these video tapes have been shown on local television stations in various parts of the country. A few of the areas showing these tapes included three showings on WKZO, Kalamazoo, Michigan; Rural Supplementary Educational Center in Stamford, New York; and the Mississippi Authority for Education Television in Jackson, Mississippi.

4. Large Three-Dimensional Models - The Center for Metric Education occupies one large room in the modern Industrial and Engineering Technology Building. To add interest and to provide visual appeal, large three-dimensional models of the various instructional materials were developed and displayed. These include the following items made ten times full size:

A. 300 millimetre rule
B. 300 millimetre vernier caliper
C. metric micrometer

Section 4

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

1. This was the first federally funded project in the area of metric conversion in the school systems of the United States.
2. This project was concerned with the metric conversion of technical career education, primarily in the areas of industrial arts and vocational education from the seventh through the fourteenth year.
3. The design of this project was to develop instructional materials and offer seminars to teacher educators from all institutions in the United States that prepare industrial education teachers with the idea that these schools would then disseminate the material to their pre- and inservice training groups.

As a first step in planning the strategy for this project, the Director visited England in early 1972 (from private funds not project moneys) to evaluate the changeover procedures and progress in that country. As a result of this trip, an insight was gained as to the major problems faced by any country in converting their educational system to the metric system of measurement.

In 1972--the starting date for this project, metric conversion was barely visible on the horizon as an educational problem. Schools had not considered this to be one of the priority items that would be facing our educational system in the years ahead. There were no qualified personnel in schools that could help in developing a program of metric conversion.

Because of these facts, the staff at the Center for Metric Education realized that an Advisory Board made up of representatives from multinational industries who were cognizant of the fact that metric conversion was an important problem, was established. This Advisory Board represented companies that were heavily involved in metric conversion planning and who were qualified to evaluate any technical instructional materials that were developed in the fields of metric conversion.

A series of advisory committee meetings were held in 1972 to develop the strategy for implementing the objectives of the study, which were as follows:

1. Study the economic implications involved in the United States moving to the metric system.
2. Evaluate the changeover to the metric system now underway in England, Australia and several other Asian-Pacific countries, and how this changeover has affected technical education.
3. Analyze selected occupations in technical areas to determine what necessary measuring abilities and competencies would be affected by the changeover to the metric system.
4. Recommend changes in career education including instructional material, machines and tools needed to convert to the metric system of measurement.
5. Develop a series of learning modules and related materials of the metric system suitable for teaching the technical and occupational areas for distribution to teacher educators.
6. The development of the instructional kits entitled GOING METRIC IN INDUSTRIAL EDUCATION were completed as follows:

A. Curriculum analysis for each instructional area was developed to determine the metric competencies needed in that particular area.

B. A plan was developed to produce a series of transparency masters and notes highlighting these competencies.

C. A preliminary copy of each transparency was developed. Then the material was checked for technical accuracy by an individual member of the Advisory Board. The complete packet of material was reviewed by the total Advisory Board at which time they made suggestions and corrections.

D. The artwork was done, printing completed, and the material was packaged.

E. To disseminate these materials, a series of regional and national seminars were offered in 1973 and 1974. Nine seminars were given with a total attendance of almost fifteen hundred teacher educators and teachers. After each seminar a complete set of the instructional material was given to each of the industrial teacher education centers throughout the United States that were represented at these seminars. In addition, an indepth, two-week seminar was held at Colorado State University to further evaluate the instructional materials.

F. As a follow-up evaluation, an extensive evaluation form was developed in cooperation with the individuals involved in the indepth seminar, the Director of the Center for Evaluation, Western Michigan University,

and staff from the U.S. Office of Education. Over sixty percent of the schools that were sent the questionnaire responded.

CONCLUSIONS

1. In the decade ahead metric conversion of our career educational system will be one of the major priority items.
2. Metric conversion will be a "future shock" to the great majority of teachers in our educational system.
3. Metric conversion is a complicated and multifacet problem, particularly in the area of industrial and vocational education.
4. Metric conversion is much more than converting a measuring system. In the field of industrial and vocational education, conversion of the measuring system itself will be the least difficult of the problem. The major problem in the areas of vocational and technical education will be the development, adaptation and implementation of the eleven thousand or more metric standards that will need to be produced before complete metric conversion is possible.
5. Metric conversion will be a slow and tedious process unless there is a carefully coordinated national policy in the field of education.
6. Metric conversion in industrial vocational education cannot be accomplished unless there are specific state and federal funds for purchasing replacement tools and equipment, particularly in the area of metalworking and auto mechanics.
7. Metric conversion will require that there be an organized program of pre- and inservice training programs so that all teachers are comfortable with this system.
8. Performance objectives for all areas of industrial-vocational education must be re-evaluated to determine the implication of metric conversion on these objectives.
9. Two systems of measurement, namely the customary (English) and the metric system, will be in operation for many years. Therefore, students in industrial-vocational education must learn both systems.
10. Metric conversion will be a much slower process than most educators envision. Countries such as England who have set up a ten-year target date for metric conversion have found it impossible to meet these deadlines. Metric conversion in England was to be substantially complete by 1975, however, at this point in time a large sector has been little affected by metric conversion.

11. Metric conversion will be opposed by a large segment of the U.S. population. This will be particularly true of people over the age of forty, who will resist the change to the metric system of measurement.

RECOMMENDATIONS

The following recommendations are made concerning metric conversion of vocational-technical education.

1. There should be a strong policy concerning metric conversion established by the Bureau of Occupational and Adult Education of the U.S. Office of Education.
2. The American Vocational Association and the American Industrial Arts Association must develop a metric policy for each of these groups and establish the necessary committees to carry out these policies.
3. Industrial teacher education centers must convert existing courses and establish separate inservice courses in metric conversion.
4. Special state and federal funding for equipment and supplies for metric conversion must be made available as soon as possible. Costs of conversion in industrial-vocational education will be high, particularly in the area of metal manufacturing and auto mechanics. Local school districts will not be able to provide these funds out of normal budget allotments.
5. Industrial-vocational educators must work closely with industry, particularly at the vocational and community college level, so that students being prepared for the world of work will be qualified to handle the metric activities and responsibilities they will find when they enter industry.
6. The Bureau of Occupational and Adult Education should work with the American National Metric Council and the Metric Conversion Board to provide all teachers with updated information concerning metric conversion. This is especially important for industrial and vocational teachers since metric standards will be in the process of development over the next ten or fifteen years. As each of these standards becomes available, the information should be easily available to all teachers.
7. The U.S. Office of Education should develop specific guidelines in addition to those developed by the consortium of states as to exactly how and how much metric conversion should be included in all instructional material produced.

APPENDIX A

INSTITUTIONS/INDIVIDUALS RECEIVING PACKETS

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHARIMAN
Alabama A & M University Normal, AL J. R. Jenkins	Yes	No	No	---
Auburn University Auburn, AL Wiley G. Hartzog	Yes	Yes	Yes	Charlotte Mc Call
Tuskegee Institute Tuskegee Institute, AL Grady W. Taylor	Yes	No	No	---
University of Alabama University, AL Norman W. Bedwell	Yes	Yes	Yes	Margaret Colman
Arizona State University Tempe, AZ Louis J. Pardini	Yes	Yes	No	---
Northern Arizona University Flagstaff, AZ Grant Holdsworth	Yes	No	No	---

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
California State University Chico, CA Charles Sours	Yes	Yes	Yes	Evelyn Marr
California State University Fresno, CA Chester Christison	Yes	Yes	Yes	Gwen C. Cooke
California State University Long Beach, CA Irvin T. Lathrop	Yes	Yes	Yes	Donna Samples
California State University Los Angeles, CA M. L. Barlow	Yes	Yes	Yes	Margaret McWilliams
California State University San Diego, CA Harold L. Marsters	Yes	No	No	---
California State University San Francisco, CA Henry Paulin	Yes	No	No	---
California State University San Jose, CA Frank A. Geraci	Yes	Yes	Yes	Elveda Smith

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Humboldt State University Humboldt, Arcata, CA Arthur L. Stegeman	Yes	No	No	---
Pacific Union College Angwin, CA Burton Pontynen	Yes	No	No	---
Adams State College Alamosa, CO Clarence Svendsen	Yes	No	No	---
Colorado State University Fort Collins, CO Maurice G. Thomas	Yes	Yes	Yes	Helen F. McHugh
Southern Colorado State University Pueblo, CO J. B. Morgan	Yes	Yes	No	---
University of Northern Colorado Greeley, CO Robert G. Hammond	Yes	Yes	Yes	Marilyn Burns
Western State College Gunnison, CO Bernard Dutton	Yes	No	No	---

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKETS REQUESTED	HOME EC. CHAIRMAN
Metropolitan State College Denver, CO David W. Parker	Yes	No	No	---
Central Connecticut State College New Britain, CT Sanford E. Rich	Yes	Yes	No	---
Florida A & M University Tallahassee, FL Freeman R. Irvine	Yes	No	No	---
Florida International University Miami, FL Kenneth T. Smith	Yes	Yes	Yes	Myrna Crabtree
Florida State University Tallahassee, FL W. Hugh Hinely	Yes	Yes	Yes	Margaret A. Sitton
University of West Florida Pensacola, FL Charles H. Wentz	Yes	Yes	Yes	Laura Tyrrell
Berry College Mount Berry, GA Lee Clendenning	Yes	No	No	---

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Georgia Southern College Statesboro, GA Donald F. Hackett	Yes	Yes	Yes	Betty Lane
Savannah State College Savannah, GA Clyde W. Hall	Yes	Yes	Yes	Evenell Terrell
University of Georgia Athens, GA William M. Gassert	Yes	No	No	---
University of Hawaii Honolulu, HI Larry Zane	Yes	Yes	No	---
Chicago State University Chicago, IL Norman G. Laws	Yes	Yes	Yes	Barbara Kardas
Eastern Illinois University Charleston, IL Robert B. Sonderman	Yes	Yes	Yes	Mary Ruth Swope
Illinois State University Normal, IL Joe Talkington	Yes	Yes	Yes	Bessie Hackett

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Northern Illinois University DeKalb, IL Eckhart A. Jacobsen	Yes	Yes	Yes	Betty Johnson
Southern Illinois University Carbondale, IL James Sullivan	No*	Yes	Yes	Anna C. Fults
University of Illinois Urbana, IL Robert Tomlinson	Yes	Yes	Yes	Hazel Spitze
Western Illinois University Macomb, IL Wendell L. Swanson	Yes	Yes	Yes	Betty Swanson
Ball State University Muncie, IN William T. Sargent	Yes	Yes	Yes	Jeanette Miller
Indiana State University Terre Haute, IN Ethan Svendsen	Yes	Yes	No	---

*This school was sent a packet even though no one attended a seminar.

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Indiana University Bloomington, IN Donald W. Kinzy	Yes	Yes	No	---
Purdue University West Lafayette, IN Daniel L. Householder	Yes	No	No	---
Iowa State University Ames, IA William Wolansky	Yes	Yes	Yes	Ruth Hughes
University of Northern Iowa Cedar Falls, IA Ronald Bro	Yes	Yes	Yes	Marilyn Story
Westmar College Le Mars, IA Rodney Scholten	Yes	No	No	---
Fort Hays Kansas State College Hays, KA C. Richard Cain	Yes	Yes	Yes	Maxine Hoffman
Kansas State College Pittsburg, KA Forest L. Penney	Yes	Yes	Yes	Mary Nell Bowman

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Kansas State Teachers College Emporia, KA Donald Froelich	Yes	Yes	Yes	Virginia Moxley
McPherson College McPherson, KA Alvin E. Williams	Yes	No	No	---
Wichita State University Wichita, KA Edgar Webb	Yes	No	No	---
Eastern Kentucky University Richmond KY Clyde O. Craft	Yes	Yes	Yes	W. Mass
Kentucky State University Frankfort, KY William W. Bearden	Yes	Yes	No	---
Morehead State University Morehead, KY Norman N. Roberts	Yes	Yes	Yes	Charlot Bennette
Western Kentucky University Bowling Green, KY Norman Tomazic	Yes	Yes	No	---

INSTITUTIONS/INDIVIDUALS RECEIVING PACKETS	ATTENDED SEMINAR	EVALUATION FORM RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Northern Kentucky State College Highland Heights, KY Ralph D. O'Brien	No*	No	No	---
Murray State University Murray, KY C. Dale Lemmons	Yes	Yes	Yes	Alice Koenecke
Grambling College Grambling, LA F. M. Lloyd	No*	No	No	---
Louisiana State University Baton Rouge, LA Philip W. Hansen	Yes	Yes	Yes	Ruth H. Sylvest
Northwestern State University Natchitoches, LA Nedom C. Muns	Yes	Yes	Yes	Bobby Alost
Southeastern Louisiana University Hammond, LA Benjamin Alsip	Yes	Yes	Yes	Virginia Langston

*This school was sent a packet even though no one attended a seminar.

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Southern University and A & M College Baton Rouge, LA Earl Gray	Yes	No	No	---
University of South-western Louisiana Lafayette, LA Thomas A. Nevitt	No*	No	No	---
University of Maine Gorham, ME Howard Faulkner	Yes	Yes	Yes	Virginia Morrill
University of Maryland College Park, MD Donald Maley	Yes	No	No	---
Fitchburg State College Fitchburg, MA Edward T. Donnelly	Yes	No	No	---
Andrews University Berrien Springs, MI L. L. Reinholtz	No*	Yes	No	---
Central Michigan University Mt. Pleasant, MI Oliver Oberlander	Yes	Yes	Yes	Harry J. Busselen

*This school was sent a packet even though no one attended a seminar.

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Eastern Michigan University Ypsilanti, MI H. James Rokusek	Yes	Yes	Yes	Billie L. Sands
Ferris State College Big Rapids, MI John VandeMalen	Yes	No	No	---
Michigan State University East Lansing, MI C. Blair MacLean	Yes	No	No	---
Northern Michigan University Marquette, MI George L. Baker	Yes	Yes	Yes	Blanch Wise
Wayne State University Detroit, MI G. Harold Silvius	Yes	Yes	No	---
Western Michigan University Kalamazoo, Michigan John Lindbeck	Yes	Yes	Yes	Sue Coates
Bemidji State College Bemidji, MN Harlan L. Scherer	Yes	Yes	No	---

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Mankato State College Mankato, MN Donald Anderson	Yes	Yes	Yes	Jean Kalenberger
Moorhead State College Moorhead, MN Wade Swenson	No*	No	No	---
St. Cloud State College St. Cloud, MN William H. Kemp	Yes	Yes	No	---
University of Minnesota Minneapolis, MN David Bjorkquist	Yes	Yes	Yes	Joan McFadden
University of Minnesota Duluth, MN Bernard J. DeRubeis	Yes	No	No	---
Winona State College Winona, MN J. H. Capron	Yes	Yes	No	---
Alcorn Agricultural and Mechanical College Lorman, MS George W. Marshall	No*	No	No	---

*This school was sent a packet even though no one attended a seminar.

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN.
Mississippi Valley State University Mississippi State, MS Richard J. Vasek	No*	Yes	Yes	Jean K. Snyder
University of Southern Mississippi Hattiesburg, MS E. Max Hunter	Yes	Yes	Yes	Sarah Weaver Gibbs
Central Missouri State University Warrensburg, MO Robert E. Goetz	Yes	No	No	---
Northeast Missouri State University Kirksville, MO Robert F. Nagel	Yes	No	No	---
Northwest Missouri State University Maryville, MO John Rhoades	Yes	Yes	Yes	Margaret A. Briggs
Southeast Missouri State University Cape Girardeau, MO Bryce D. March	No*	No	No	---

*This school was sent a packet even though no one attended a seminar.

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Southwest Missouri State University Springfield, MO Orin Robinson	Yes	Yes	Yes	Jackie Ledbetter
University of Missouri Columbia, MO Franklin J. King	Yes	No	No	---
Montana State University Bozeman, MT Francis Sprinkle	Yes	Yes	Yes	Marjorie Kaiser
Western Montana College Dillon, MT Clayborn J. Anders	Yes	Yes	No	---
Chadron State College Chadron, NB John L. Bobell	Yes	Yes	No	---
Kearney State College Kearney, NB Kenneth Carlson	Yes	Yes	Yes	Wilma Larson
Peru State College Peru, NB Lester Russell	Yes	Yes	Yes	Arlene Fell

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
University of Nebraska Lincoln, NB Neil Munson	No*	No	No	---
Wayne State College Wayne, NB Neil Edmunds	Yes	Yes	Yes	Eena Adams
University of Nevada Reno, NV Ivan E. Lee	Yes	Yes	Yes	Patricia Tripple
Keene State College Keene, NH Leonard Aldrich	Yes	Yes	Yes	Spangenberg
Glassboro State College Glassboro, NJ John Humbert	No*	Yes	Yes	Hodes
Montclair State College Upper Montclair, NJ Arthur Rosser	Yes	Yes	Yes	Katherine Hall
Trenton State College Trenton, NJ J. Russell Kruppa	Yes	Yes	No	---

*This school was sent a packet even though no one attended a seminar.

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Eastern New Mexico University Portales, NM William J. Rosin	Yes	Yes	Yes	Vera Murphey
New Mexico Highlands University Las Vegas, NM Harold Brandt	Yes	Yes	Yes	Elaine MacDowell
University of New Mexico Albuquerque, NM Robert D. Nesbitt	Yes	No	No	---
New York University Washington Square New York, NY Ronald Todd	Yes	No	No	---
State University College Buffalo, NY Kenneth L. Schank	Yes	Yes	No	---
State University College Oswego, NY Vernon Tryon	Yes	No	No	---
City University of New York New York, NY Robert Ezrol	Yes	Yes	No	---

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
State University of New York Buffalo, NY Albert Pautler	Yes	No	No	---
Appalachian State University Boone, NC Carl A. Moeller	Yes	Yes	Yes	Josephine Foster
East Carolina University Greenville, NC N. C. Pendered	Yes	Yes	No	---
North Carolina State University Raleigh, NC E. Allen Bame	Yes	Yes	No	---
Western Carolina University Cullowhee, NC Samuel White	Yes	No	No	---
University of North Dakota Grand Forks, ND Emert Breznary	Yes	Yes	Yes	Ramses Toma

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Valley City State College Valley City, ND Michael Dyrenfurth	Yes	No	No	---
Bowling Green State University Bowling Green, OH Jerry Streichler	Yes	Yes	Yes	Edith W. Andrews
Central State University Wiberforce, OH Max Kanagy	Yes	Yes	No	---
Kent State University Kent, OH Manford B. Rotnem	Yes	Yes	Yes	Theodore Irmiter
Miami University Oxford, OH Charles A. Bunten	Yes	Yes	Yes	Jane Reese
Ohio Northern University Ada, OH Albert Squibb	Yes	Yes	No	---
Ohio State University Columbus, OH Gloria Cooper	No*	Yes	Yes	Lena Bailey

*This school was sent a packet even though no one attended a seminar.

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
University of Akron Akron, OH Michael Sugarman	No*	Yes	Yes	Joyce Sullivan
Cleveland State University Cleveland, OH Donald L. Karr	Yes	Yes	No	---
Central State University Edmond, OK Loren W. Smith	Yes	Yes	Yes	Donna Edwards
East Central State College Ada, OK Harold Brenholtz	Yes	Yes	Yes	Grace George
Northeastern Oklahoma State University Tahlequah, OK Vernon Isom	No*	Yes	Yes	Evelyn Cottrell
Northwestern State College Alva, OK Jerry Brownrigg	Yes	Yes	Yes	Norma Jean Smith
Oklahoma State University Stillwater, OK Harold J. Polk	Yes	Yes	Yes	Elaine Jorgenson

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*This school was sent a packet even though no one attended a seminar.

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INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Southwestern State College Weatherford, OK James F. Griffin	Yes	Yes	Yes	Hellen Brown
Oregon State University Corvallis, OR Pat H. Atteberry	Yes	Yes	No	---
California State College California, PA John R. Swearingen	Yes	No	No	---
Cheyney State College Cheyney, PA John Fecik	Yes	No	No	---
Millersville State College Millersville, PA George H. Ditlow	Yes	Yes	No	---
Pennsylvania State University University Park, PA Ronald Koble	No*	Yes	Yes	Marjorie East
University of Pittsburgh Pittsburgh, PA James Pellegrino	Yes	No	No	---

*This school was sent a packet even though no one attended a seminar.

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Rhode Island College Providence, RI Edward D. Bzowski	Yes	Yes	Yes	Home Economics Dept.
Clemson University Clemson, SC Ben Smith	Yes	Yes	Yes	Home Economics Dept.
South Carolina State College Orangeburg, SC A. E. Lockert, Jr.	Yes	No	No	---
Black Hills State College Spearfish, SD Leonard Edwards	Yes	Yes	No	---
Northern State College Aberdeen, SD Marvin Burroughs	Yes	Yes	No	---
Austin Peay State University Clarksville, TN H. Leon Bibb	Yes	Yes	No	---
East Tennessee State University Johnson City, TN John Ephraim	Yes	No	No	---

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Memphis State University Memphis, TN Wilfred M. Bates	Yes	Yes	No	---
Middle Tennessee State University Murfreesboro, TN M. R. Bachler	Yes	Yes	Yes	Hattie Arthur
Southern Missionary College Collegedale, TN Drew M. Turlington	Yes	No	No	---
Tennessee State University Nashville, TN E. L. Witherspoon	Yes	No	No	---
Tennessee Technological University Cookeville, TN William H. Lewis	Yes	No	No	---
Abilene Christian College Abilene, TX Jerry Drennan	Yes	Yes	Yes	Donice Kelley
East Texas State University Commerce, TX Welcome E. Wright	Yes	Yes	Yes	Judy Wilson

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
North Texas State University Denton, TX Earle B. Blanton	Yes	No	No	---
Prairie View Agricultural & Mechanical College Prairie View, TX Samuel Collins	Yes	Yes	Yes	Flossie M. Byrd
Sam Houston State University Huntsville, TX Stephen Randel	Yes	Yes	Yes	Mattie B. Medford
Southwest Texas State University San Marcos, TX Victor L. Bowers	Yes	Yes	Yes	Mary Wanda Harp
Sul Ross State University Alpine, TX Jack C. Crawford	Yes	Yes	No	---
Tarleton State College Stephenville, TX James C. Leeth	No*	No	No	---

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*This school was sent a packet even though no one attended a seminar.

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INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
Texas A & M University College Station, TX James L. Boone, Jr	Yes	Yes	No	---
Texas Southern University Houston, TX Clarence Robinson	Yes	Yes	Yes	Jannie Cotton
University of Houston Houston, TX Pete Martinez	Yes	Yes	No	---
West Texas State University Canyon, TX W. L. Johnston	Yes	No	No	---
Brigham Young University Provo, UT Edwin C. Hinckley	Yes	No	No	---
Southern Utah State College Cedar City, UT Don L. Blanchard	Yes	No	No	---
Utah State University Logan, UT Neill C. Slack	Yes	No	No	---

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
University of Vermont Burlington, VT Thomas Bloom	Yes	No	No	---
Norfolk State College Norfolk, VA Clarence Ash	Yes	Yes	Yes	Amella Adams
Old Dominion University Norfolk, VA Fred Culpepper	Yes	No	No	---
Virginia Polytechnic Institute & State University Blacksburg, VA William E. Dugger	Yes	Yes	Yes	Ruth Harris
Virginia State College Petersburg, VA W. Vincent Payne	Yes	Yes	Yes	Julia R. Miller
Central Washington State College Ellensburg, WA Stanley A. Dudley	Yes	Yes	No	---
Eastern Washington State College Cheyney, WA Glen O. Fuglsby	Yes	No	No	---

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
University of Washington Seattle, WA Athol R. Bailey	Yes	Yes	Yes	Mary Louise Johnson
Walla Walla College College Place, WA Lewis Canady	Yes	Yes	Yes	Mary Schwantes
Washington State College Pullman, WA O. K. Schaer	Yes	No	No	---
Western Washington State College Bellingham, WA Richard Vogal	Yes	No	No	---
Fairmont State College Fairmont, WV James A. Hales	Yes	Yes	Yes	Home Economics Dept.
West Virginia Institute of Technology Montgomery, WV Thomas Latimer	Yes	Yes	No	---
West Virginia State College Institute, WV Richard N. Gwinn	Yes	No	No	---

INSTITUTION/INDIVIDUAL RECEIVING PACKET	ATTENDED SEMINAR	EVALUATION FORMS RETURNED	HOME EC. PACKET REQUESTED	HOME EC. CHAIRMAN
West Virginia University Morgantow, WV Donald P. Lauda	Yes	Yes	Yes	Home Economics Dept.
University of Wisconsin-- Platteville Platteville, WI Jack Kirby	Yes	Yes	No	---
University of Wisconsin-- Stout Menomonie, WI Herbert A. Anderson	Yes	Yes	Yes	Anthony Samenfink
University of Wisconsin-- River Falls River Falls, WI Russell Gerber	No*	Yes	No	---
University of Wyoming Laramie, WY Lyndall Lundy	Yes	Yes	Yes	Delores Gade

*This school was sent a packet even though no one attended a seminar.

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APPENDIX B

EVALUATION OF METRIC KITS

GOING METRIC FOR STUDENTS

General Critique:

This is a good starter unit, which I believe can be used at practically any level. Of course, the reading is too hard for the lower grades, but certain portions could be used such as the practical problems. Math departments should use this as a regular unit. After the basic background kit, the industrial arts, drafting, machine shop and etc., should continue on with "advanced kits" and practical application.

Use more comparison problems showing the students the easy use of metrics over the old customary English system. "All You Need to Know About Metric". This chart is good, but I feel should have more comparison illustrations, perhaps of things that are "real" to the student such as: cars, bikes, stereos, etc.

In the center column (or wherever SI words appear) on the "Comparing the Most Common Measurement Units" chart, I feel the symbol should be shown behind the word such as: metre (m), etc.

"Programmed Units". I would suggest that the answers be available for the student on a separate sheet. I believe it is too easy for the student to look at the answer when he/she is not sure rather than "think a little bit".

This kit, "Going Metric for Students", did not measure up to the other kits I looked at. It was poorly organized in some areas, unnecessarily repetitious and loaded with errors (a few of which I marked).

Some answers to the exercises were difficult if not impossible to find on the accompanying answer sheets. Other exercises were silly and impractical. For instance, who is going to figure 1.3 kg as 1 300 000 mg?

In some cases small technical errors were made. Amounts less than one did not always have the decimal preceeded by a "0". Once we are told that 10 l = 1 m^3. The sheets are not uniform in following capitalization rules for metric units. The enclosed converter lists °C as C°.

I did not feel the introductory masters were complete. An instructor would need more materials to choose from to give an effective presentation. Also these masters had too much information packed on them. Two or three different masters would be better. If there is too much material on one master, students tend to turn it off as too hard to comprehend even when it is not.

The best part of this kit is the programmed learning sheets. They are clear and easy to follow with everyday examples. Another good point of this kit is the idea of providing the student with hands-on measurement tests. The student is not told what size things are, but he gets to determine this size himself.

I like the worksheets that are given for the students to use in this packet. I think they will give the student a good understanding of the basic units in SI metrics.

As I mentioned above, the masters should be more simple. They should not give out so much material on one master. It would be better if they took one area on a master and made it into a complete master. For example, the master that has weight, liquid measures, conversion factors. Each of these areas could be made into a separate master.

I would like to point out that this is a good learning packet. The worksheet will make up for the master. I think maybe a little work could improve the kit.

I feel that this packet would be very helpful to beginning students in teaching metrics. Most schools now use some metrics in some of the sciences. I think that it is valuable for students to become familiar with SI units and ISO terminology that will be used in industry. I think that beginning material should be really basic, and hopefully interesting enough for young kids. Some of this material is quite technical, and I think that junior high kids might have trouble with it.

EVALUATION OF METRIC KITS

GOING METRIC FOR CAREER EDUCATION

General Critique:

This is one of the better learning packets. The strong points are the outstanding masters in the packet. The use of cartoon figures will help keep the students interested in the subject matter as it is being covered.

I like the way the packet breaks down SI metrics into a family. I think this will help the student remember the relationship the family has on each other.

The masters are simple so the student can get the information off the masters very easily. This was a fun learning packet, and I think many students would feel the same way about the learning packet. The learning packet could be used both in elementary classes and in junior high classes very easily.

I believe this to be an excellent introduction to metrics. I do wonder how the kit, other than dealing with metrics, set itself out as a career education packet. There is much controversy about the definition of career education. This kit does not fit into my personal definition of career education. I do think, however, that this kit gives a good basic overview of metrics.

The use of the cartoon characters is an excellent method to create interest in metrics. The relationship of known objects is important in order to show comparison. Throughout this kit this is done. One transparency that is difficult to interpret is "The Bushel Varies". I would eliminate this one.

Of the three metric kits that I have critiqued (Going Metric for Students and Going Metric in Drafting) this kit was by far the best. The kit assumes nothing; it starts from "scratch" explaining the different areas by word and by illustration.

This kit as well as the one for student may be used at all grade levels. I feel that if the student had this kit as the introduction and then a follow-up with the kit

for students that he would have an excellent background in the field of SI metrics. I would hope that in high school drafting the student would have had these two kits and then the drafting kit would be much more meaningful of a learning experience.

I would recommend that various charts and masters be made into wall posters that would be visible at all times, especially in the elementary grades.

This kit is most definitely one of the best collections of material available for giving a student a general, overall (coverage) idea of what to expect from metrication. It touches the important facets and facts (basic) needed for implementing a metric program. The material is readily understood and extremely easy to understand. Its effectiveness on a junior-senior high school level should be extremely high. The material is presented in such a way that the student could relate to size comparison or equivalencies through the popular everyday objects dimensioned in many of the masters. Also the presence of a cartoon figure in many of the masters should aid in keeping the student's attention and limit any chances of "daydreaming" or boredom.

But, again, I feel that the level at which this material is presented should be limited to no higher than high school--except where a learning handicap is present. Presenting this material to "adults" might in many cases offend them due to the "lowering of their levels".

I must honestly say that I am impressed with this kit and feel it is one of the best introductory materials that a student can obtain about metrics before encompassing any specifics. I would not change a thing!

EVALUATION OF METRIC KITS

GOING METRIC IN DRAFTING

General Critique:

These materials should be very helpful to me in teaching mechanical and architectural drawing. I have been curious about which metric scales to use, and this set of material has excellent explanations of the metric scales.

I do question the value of the first angle projection in any drafting situation because of its complete disorientation of views in any logical relation to one another. I have enough problems getting students to understand regular orthographic projection and location of views without additional confusion. These are the only masters which I would not use in my instruction.

I felt that too much was assumed in this kit, especially if the student had no previous background in metrics. It would be much easier for the student if he had had the kit of "metrics for the student" first. I thought this was an excellent introductory kit. I felt that there should be a separate kit on threads and fasteners especially as important as this area is.

Some of the charts are excellent and of great value as the ratio comparison chart, preferred metric scales, enlargement and reduction scales, decimals of an inch to millimetres, fractions to inches and the comparison chart on size of paper. It would be helpful to have these charts made into large (ISO A0 or A1) wall charts that are visible at all times.

Reference sheets should be included. Also lists of any new texts, films or filmstrips. Also the address of any official government or private offices where additional SI--ISO--ANSI information could be available.

This packet would be good for experienced drafting students or for professional draftsmen. For the average secondary classroom, however, it is much too detailed, repetitious and lengthy. Ten consecutive masters on scale comparisons, for instance, would not hold the average

student's attention for very long. Much of the tabular information (a total of approximately 15 sheets) are of little immediate interest other than to know what is available. They would be of more use in booklet form or on wall charts

This set also needs to be edited for small technical errors. Rounding off rules are not always followed. The very first transparency is useful and is easy to understand, but the rule is incorrectly marked in centimetres instead of millimetres. More use should be made of learner participation transparencies. The class should get experience making scale readings and finding conversions and standards on the charts.

The material assembled in the "Going Metric in Drafting" kit is the most concise material I have found. I have looked at every page, and it is job well done.

I have become motivated to units in metric for beginning, advanced and architectural drafting classes for Bear Creek High School. This kit will be most helpful in developing learning units, metric competency, performance objectives, activities and evaluations.

The "Notes and Comments" are brief and an excellent reference to each of the diagrams. The noted changes in abbreviations and the difference between ANSI and ISO geometric characteristic symbols is significant.

Learning to read the metric rule with reference to the linear measurements is well done. The architect's scale comparisons are very well illustrated.

Dimensioning methods in the kit will be of great interest to the student when properly presented in learning units.

All the charts and materials included in this kit will be of great value in developing learning units, objectives, activities and evaluation.

What is in this kit could be used at both the junior and senior high school level as well as in the first year of university.

My bias is that TM's be developed for junior high school classes because it is here where we will have to immerse the students into SI and ISO drafting practices. Because of this I would like to see a set of TMs that are closer related in sequence that could be used to help the individualization of instruction.

EVALUATION OF METRIC KITS

GOING METRIC IN METALWORKING

General Critique:

I don't feel that there should be so much reference to English system, e.g. in reference to part one, where the paper states that the mm is between the 1/32 and 1/64 of an inch. I think that this should be omitted and only metric reference made. Students can look at a metric scale if they need a visual comparison. Also, since dual dimensioning is not recommended it should be omitted from the course outline.

The transparencies would be very valuable as visual aids or in the form of handouts. Again, I think that the material on dual dimensioning should be omitted.

The masters on reading a rule were or would be confusing to a student. The examples are marked in cm when measurement is to be done in mm. Also one example has mm on one side of the rule and 1/32 of an inch on the other side.

The other parts of the kit were good. The pictures related to measuring tools were good and examples large enough to use effectively. It has possibilities for overlays and multi-color.

The conversion of machines to metric and the heat treating chart were important. The conversion will be gradual and many machines and gages will be converted rather than be replaced.

Of the three kits reviewed this one by far was the most complete. It was the most comprehensive with charts of many of the practices that occur in the metal trades. These charts will be useful in helping the beginning student.

The information regarding the conversion of equipment is also useful in explaining to the student the changes that will take place in machinery. Even if the student does not get to use the equipment in its modified form, he will at least have the knowledge of its use for a future date.

My only real criticism of the kit was the lack of information on metrics as it affects the steel producing industry. That is vital for all in the industry.

I found the kit, GOING METRIC IN METALWORKING, to have great potential for classroom use. Although quite basic in the material covered, it did a good, thorough job of detailing information on measuring tools, illustrating the different types and how to read them. The information on graphic representation, which included rules for metrics as well as dual dimensioning, was also well done. Thorough, basic and well illustrated.

However, where do we go from here? The material covered was quite basic. Are there to be supplementary packets? How about coverage of materials, gauging, which is involved in actual conversion in the shop? More on thread designation.

The masters in the metalworking kit are useful and well drawn. They are clear and show the necessary information to help in teaching each concept of metric measurement in metalworking.

I would suggest the lettering be kept to at least 5 mm in height. This helps make the projection easier to read when the projection distance is limited. The 2 masters on vernier calipers would also be improved if they were larger.

The explanation for each master is very good and will serve as a valuable part of the total program.

The material presented in the metalworking kit appears to present a very good basic or overall (general) introduction to metric conversion. It presents the bare essentials--just touching key areas without causing boredom or undesirable response due to lengthy coverages of material presentation. In the particular case where an individual desires additional information on one or more areas of the particular subject, material should be made available on that one particular fact(s). It would be a type of follow-up program.

I feel that the program implemented on a junior or high school level would be extremely effective due to the ease of understanding and the nature of the way the material is presented. It should also be effective where an individual (in the industry, for instance) has an incapability of comprehending material on his own level. On a college, vocational school or industrial (laymen in the field) level, I feel that the material is most definitely too easy--not that it does have to be complex--but somewhat of a "challenge" (using the word as to explain that the material is fairly easy and might be resented by "lowering one's intellectural level").*

The only complaints I have about this kit is the misuse of metric rules using centimetres and the vernier represented in centimetres. The use of centimetres, as I have learned, is undesirable SI when used on rules or scales.

* Much of the material could successfully be presented on industrial levels (lay as well as administration) especially some of the charts and diagrams.

EVALUATION OF METRIC KITS

GOING METRIC IN GRAPHIC ARTS

General Critique:

The material seems to be quite complete--in a very specialized area. Presents enough material to leave the viewer with a good understanding of what the situation will be in graphic arts. Correlations of sizes of paper and sizes of envelopes are quite clear. My question though is this, what level is this packet designed for? This material seems to be of a somewhat specialized nature and quite technical. If the material is for an advanced graphics study, it seems there should be more material.

In general, this kit is obviously geared toward someone in industry who has a strong printer's background. The conversion charts are excellent in this situation where common sizes of paper are already known. For then all that is necessary is a simple memorization of paper inch sizes to millimetres. With this in mind the transition will be simple.

Now, when speaking of a student in graphics class the situation is quite different. As a beginning student, the charts are fine, but he also needs more visual aids such as true paper comparisons and millimetre rules, etc. As the kit is in its present form, it would not meet the needs of a graphics student learning metrics as it relates to the working industry.

I feel this kit is a fairly good technical representation of the graphic arts conversion. Although I do not think it would be successful on the junior or senior high school levels as described in the previous critiques. It is much too technical. The way the subject matter is presented graphically and with the use of charts might tend to "bore" the student and lose his fullest attention. But on the industrial level, I feel it is a good, concise program. The graphical representation permits the viewer to get an idea of the proportional comparison between the new ISO paper standards and how nicely it conforms from one size to another. It also depicts the ease at which certain paper sizes will fit in certain ISO standardized

envelopes. The charts too allow the lay or administration (and those people in the middle) level to see comparisons in numerical value between the ISO paper and envelope sizes and the equivalent customary values.

Although I feel that this kit will not be too successful on the high school level, I do think it should prove effective throughout the industry and "upper level".

The material in this unit will have to be expanded to include linear measuring devices normally found in a vocational education graphic arts shop.

A learning activity package should be developed that could use the TM's to help reinforce learning.

It might be advantageous to include the name of two or three of national suppliers of paper who could supply teachers of graphic arts with their ISO paper sizes.

EVALUATION OF METRIC KITS

GOING METRIC IN WOODWORKING AND BUILDING CONSTRUCTION

General Critique:

Generally the transparencies and accompanying note sheet were simple, easy to understand and offered interesting and useful information. However, I feel that detailed and complicated tables such as lumber charts and boring charts should be on wall charts rather than transparencies for normal classroom use.

Especially good were the sheets on approximate metric equivalents of familiar tools. (Tools which will not need replacement and boring tools which will not need replacement.) They help the student and teachers alike to begin actually visualizing in metric terms rather than customary units.

The three metric dimensional drawings also help the learner visualize in metrics but most importantly show the simplicity and clarity of dimensioning in only millimetre terms.

The best thing about this kit is that it begins to dispell "the metric scare". People can readily see (especially the beginner or slow learner) it is easier to figure out that a 7 mm drill is smaller than a 8 mm drill. In customary units figuring sizes is not always so easy. Which is larger? 7/32" or 13/64"?

The only critical thing I can find with the material is in the notes and comments for #4 on page 2, the last sentence, "The same logic obtains--". I question the use of the word obtains.

The information contained in the materials for woodworking is excellent. It will all be especially useful to us in our woodworking program. I would like to see more information pertaining to building trades, however, I do realize that this material may not be available at this time.

Thank you for the opportunity to critique the materials and to acquire copies.

This kit can easily be integrated into a woodworking class. It is evident in this packet that woodworking and construction will be one of the last areas affected by a change to metrics. Most woodworking classes follow the project approach to learning. With this kit, metrics can be a two or three week unit. As I understand it, most of the metric conversion in the woodworking area is yet to come. This is an excellent introductory unit.

Generally speaking, I was very impressed with this kit over the graphics kit. It has many useful charts that will enable the students to visually see the comparisons between mm and standard inch system. In this they can readily begin to associate the new language and break the old.

I think more inclusions of possible projects could be used to a great advantage if approached right. A project such as the table could spark great enthusiasm while the students would be forced to familiarize themselves with metric measurement.

In closing, I feel that all the kits should contain a description of what machines will need alteration to conform to metric usage. The one you have in this kit is a good start.

The conversion/immersion issue takes priority in any critique of this instructional unit. If one believes in total immersion, then he would not purchase dual reading linear measuring devices. The measuring devices that are purchased should have metric capabilities only.

To improve the teaching effectiveness of TM6, "Boring Chart for Wood Screws", I would like to see a three-dimensional sketch placed above the chart. The various diameters of the screw should be labeled to make the chart more understandable by the learner.

TM 10 "Patio Table". I would like to see an incomplete bill of materials used. This would help to reinforce the learning of the student to learn metric terminology.

TM 11"Small Car Garage". There is a question attached to this plate, Is the window in the East wall in the center of the wall?" If it was intended to be, measuring it with the millimetre drafting scale handed out in class, it is

incorrectly dimensioned. The dimension should be 1800 mm instead of 1700 mm.

It is evident that a considerable amount of time and effort went into this instructional unit. On the whole I believe that it is well done.

EVALUATION OF METRIC KITS

GOING METRIC--COURSE OF STUDY AND TOOL KITS

General Critique:

The packet on tool kits was very thorough, and I felt that it was well prepared and organized. I thought that the price lists proved to be quite helpful along with the addresses of manufacturers.

The course outline is excellent. This item alone should point out to all industrial arts teachers the importance of converting to metrics. The break down and description of how metrics will be adapted to the individual course area is good. The first question that most teachers ask is, "Where does metrics fit into my field of teaching?" The course outline points this out.

The list of references and AV materials should be useful for follow-up. Once a teacher decides to teach a unit on metrics, the gathering of information is often difficult. This section is important.

The carrying cases (and plans) can be used in the classroom and perhaps for inservice instruction for teachers. The list of equipment is very complete.

The only criticism may be that with the cases, metrics seem to be set apart from the normal course curriculum. A separate unit may be necessary in the beginning but must be totally integrated into each course.

All the masters are unique in that they give a photo of the metric material carrying case showing arrangement plus tool lists and where to purchase.

The course outline for metric measurement and ISO standards is very well done. It is especially helpful in developing teaching units for the fields of drafting, metalworking and woodworking.

The introduction of any good teaching unit or subject should have a short presentation on the history and development of the subject.

The bibliography of resource material is of great value because it represents a great time saver in looking up the reference material needed in preparing a good teaching unit.

The drawing of the carrying case could be of value to the woodworking teacher in developing an assembly line unit that would benefit both the students and the industrial arts department. Each subject area then would have its own display, storage and carrying case.

APPENDIX C

CRITIQUES OF METRIC SEMINAR

My overall evaluation of the "workshop in metrics" was that it was most informative as well as educational. From what I acquired in the past two weeks I believe that I have added to my knowledge base of SI and standards. Now I feel that I can comfortably teach the base and derived units as they apply to industrial arts. I also feel that I can teach students how to use a variety of metric measurement devices in drafting, woodworking and metalworking.

To make the workshop more meaningful, I would like to offer the following suggestions:

1. Additional time be devoted to the derived units of length, area, volume and mass. This suggestion is made so that participants of the workshop become more conversant and familiar with these units and their application in industrial arts.
2. That each self-study unit be devoted to only a single measuring device with more time at the end of each unit devoted to practice exercises. This suggestion is made so that those who participate in the workshop can learn to use and read each of the measuring devices with some degree of competency. Although there are a number of metric micrometers available, concentration should have been placed on the micrometer that will be most commonly used in industrial arts.
3. That the incremental frames for the self-study unit be more closely related and include such programming techniques as clues, promps and fading. This suggestion is made so that the self-study units are designed following the principles set by Skinner and his associate for writing programmed instruction.
4. That a list of supplies for paper and hand tools be made available to participants of the workshop. This suggestion is made so that those who attend the workshop will not have to spend their time searching out these sources of supply.

I felt the workshop was generally handled in a professional manner. I came in not knowing a great deal about metrics but feel quite a bit more knowledgeable in the subject now. The information given could be stretched to a three instead of two week workshop with possibly more retention. I'm just beginning to see all the inter-relationships of the whole metric system. I'm sure that my approach in teaching will be affected by this course.

The presentation of the metric seminar was excellent. It was well organized and very clearly explained.

The charts that were shown by the use of the overhead projector were well printed and a fine explanation of the content was given by the instructor.

The pre-test was a good instrument to show the previous knowledge of the metric system of those participating in the seminar. Then the final test was good for measuring the retention of the material presented during the seminar.

The self-study books that were used on the various course units were a very good method of learning the material.

The kits that were presented gave the students an excellent chance to review and critique the ones of special interest.

The filmstrips were well presented in that they were brief and to the point.

I was happy that C.S.U. offered the seminar and it was a privilege to take it under one who presented it so well.

If I were to take another course in SI, I would want to specialize in my particular area of course.

At the beginning I thought that we were getting too much information--but now I can see the reason. I can see the overall scope that will have to be involved in the change to metrics.

Perhaps a little more time could be spent with the work-study bit. I sometimes felt hurried to complete the material. I feel that these study bits are very important in learning the various areas of SI.

Thank you for the new insight into metrics. I feel now that with a little more work I will be able to teach my students some base metrics.

It would have been interesting to discuss the problems of convincing people to go metric in more detail. The

workshop was excellent, and I received much up-to-date information that I intend to use.

I thought the programs on metrics were good learning tools. The information was reinforced.

I have been wanting to gain knowledge through a metric workshop for the past three years. I, therefore, feel by completion of this workshop I have achieved a worthwhile, meaningful goal.

My evaluation of the workshop is A+. The only thing that needs to be done to make it better is to edit the materials and correct the few minor errors in the tests and worksheets.

Thanks for your fine presentation of this workshop. I hope I can do as well with teaching metrics to my high school classes.

Workshop was very good. Only area for improvement is to let the students know there will be some drawing so the students will have their drawing equipment.

Also, it would have been helpful to know about the unit plan earlier so we could have done (hopefully) a better job on the assignments.

Course was very well designed, and I got a lot of information from it.

I found the material to be easily understood and potentially valuable to all as a member of society as well as my future role as an educator. Material was new, and I recognize the need for review and overlapping of materials, but I think the time each day needs to be broken up with other types of activities. Some other types of hands-on experiences other than the drawing.

Otherwise--well done.

The amount of material that was presented was extensive. In two weeks I feel we have covered metrics as it

relates to industrial education quite thoroughly.

The exercises in drafting were excellent, but the ones in woodworking and metalworking were merely more drafting. I realize it is difficult to present this material, but actual measuring exercises would be helpful (ruler to object).

I enjoyed the opportunity to see future developments in industrial education.

Having previously had a seminar with Lou Sokol, I have something to compare this workshop to. This class was much more indepth and covered many more things in the areas of standards and practices.

The extensive amount of learning units, written exercises and actual drafting practice gave us experience in all the areas which are of importance to use as teachers and future teachers. The information offered was for the most part interesting and useful.

Some of the more technical data was, however, of limited use at best. On the whole the workshop was well done and relevant to our future use.

I thought the seminar was very educating. Before this course I have had no background (very minor) in metrics as shown on my first test score (pre-test). Overall I would honestly say that the seminar was as excellent introduction to metrification. It covered most pertinent aspects and areas in this conversion. It showed a good set of ideas on how to implement metrification in different fields (kits) as well as the "ease" at which it could be done in most circumstances especially soft conversion. I really don't think I am presently in a position to truly suggest any changes that should be made because of my lack of experience in educational practices. But, I felt every bit of it was worthwhile, and thank you for the two weeks of very helpful information.

In a future seminar it might be well to add a small unit for teachers on how to prepare the performance objectives. Also a suggestion on the best place to place the unit on metrics. Toward the end of a semester of learning

seems to me the best spot to present it.

As time goes on, it would be nice to know of new developments in the program.

APPENDIX D

RESUME

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I. Business Address:

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II. Educational Record:

1966-1972 Brigham Young University, Provo, Utah (B.S. in Psychology)

1972-1975 Brigham Young University, Provo, Utah (M.Ed. in Educational Psychology, emphasis in Educational Evaluation)

1975-1977 (expected) Western Michigan University, Kalamazoo, Michigan (Ph.d. in Educational Leadership, emphasis in Educational Evaluation)

III. Employment History:

September 1972 - October 1973 Graduate Internship in Instructional Evaluation and Testing, A. P. Van Mondfrans, Brigham Young University.

November 1973 - February 1974 Evaluation Internship, J. R. Sanders, Northwest Regional Educational Laboratory. Participated in goals selection for Oregon Statewide Assessment Project.

March 1974 - December 1974 Evaluation Specialist, W. J. Wright, Rural Education Program, Northwest Regional Educational Laboratory. Major responsibility for planning, conducting and reporting evaluations of development activities of the Rural Education Program.

January 1975 - August 1975 Graduate Internship Department of Instructional Evaluation and Testing, A. P. Van Mondfrans, Brigham Young University.

September 1975 - Present Research Associate in Evaluation Center, Daniel L. Stufflebeam, Western Michigan University.

IV. Papers Presented:

Hughes, J., Quinn, D. W., Black, H. B. Encoding of visual images in short-term memory. Paper presented at the California Educational Research Association, Los Angeles, 1972.

Quinn, D. W. Institutional needs assessment. Paper presented at the California Educational Research Association, San Francisco, 1974.

Quinn, D. W. Latent trait test theory models. Part of a symposium presented at NCME, Chicago, 1974.

Quinn, D. W. et al. Infant preconditioning to visual stimuli. Paper presented to Provo Rotary Club as a report of a research grant, Provo, Utah, 1972.

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